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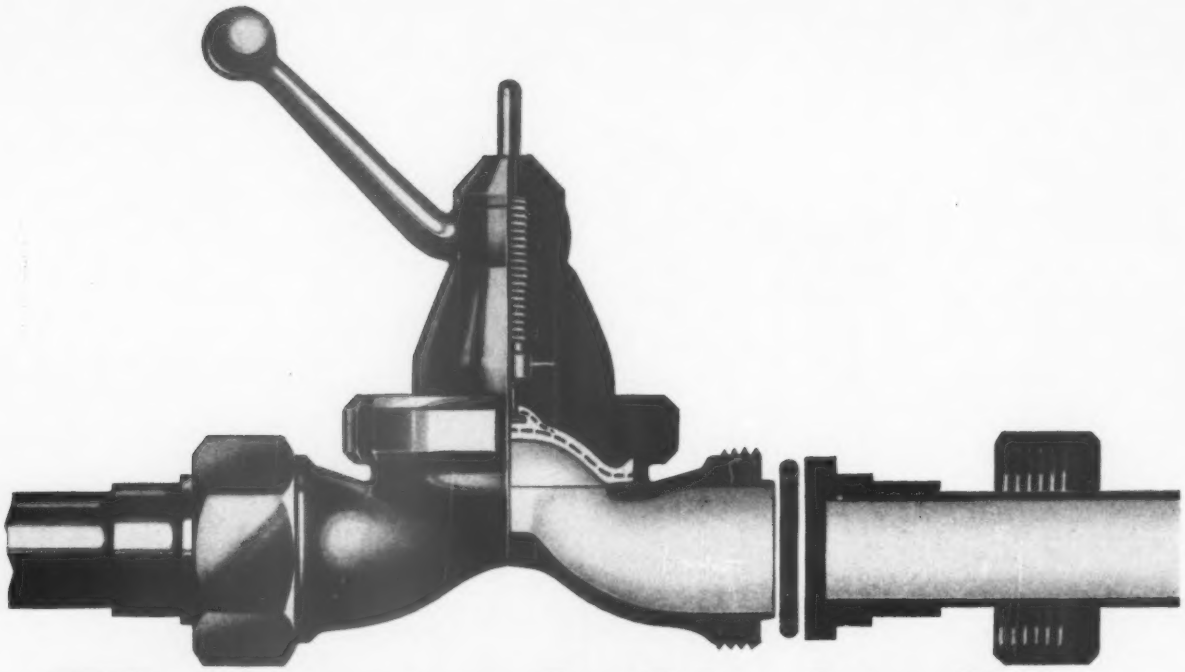

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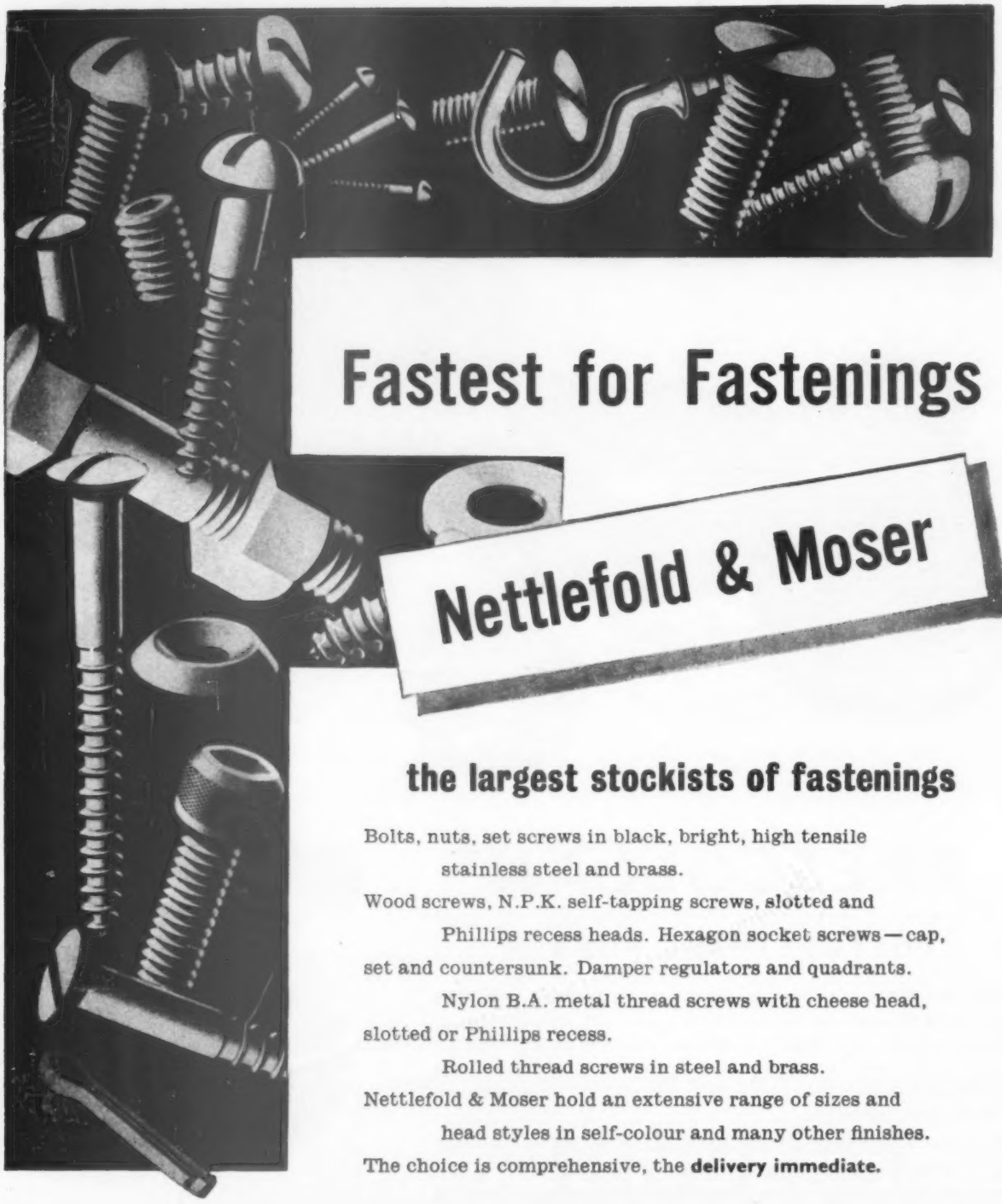

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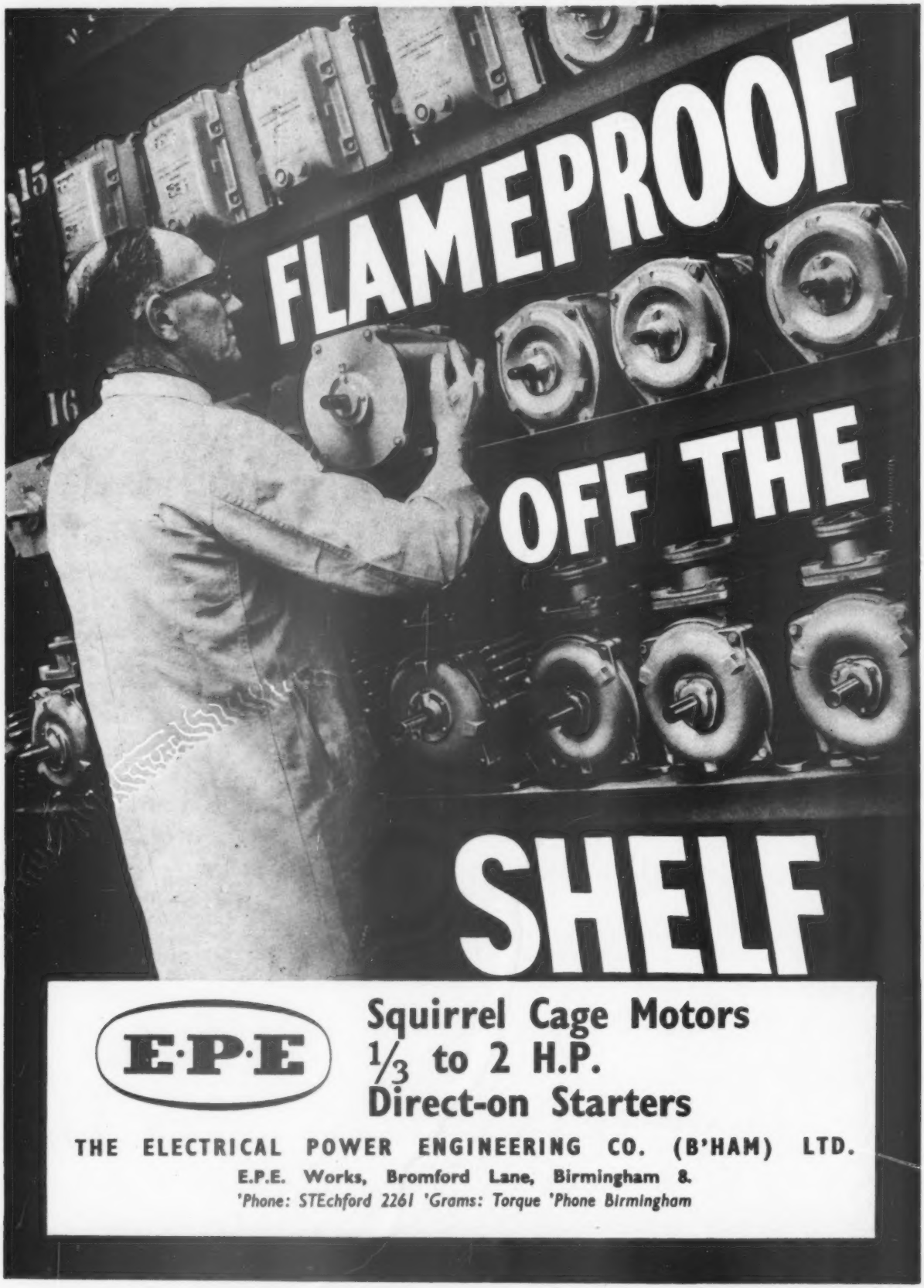

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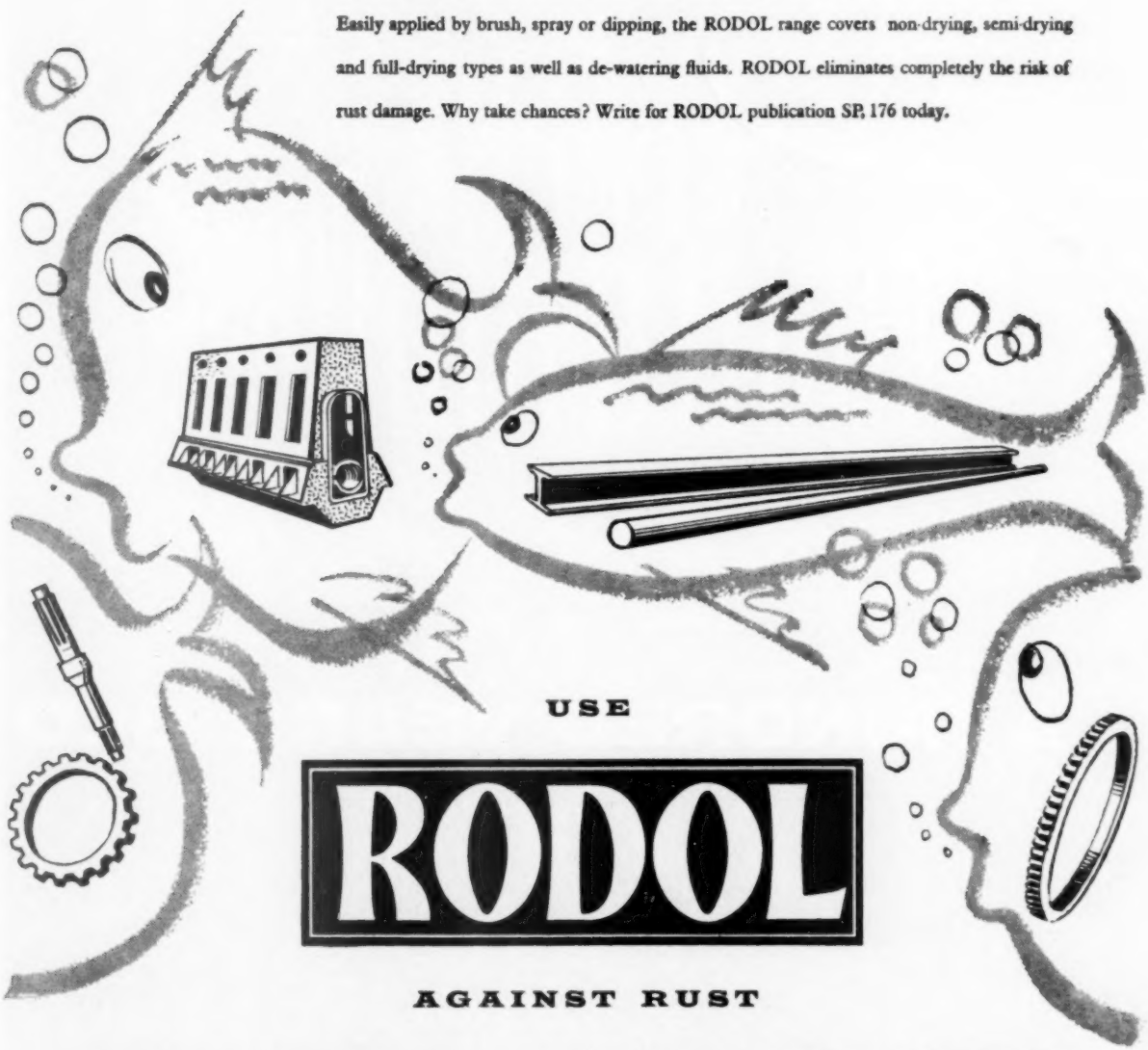

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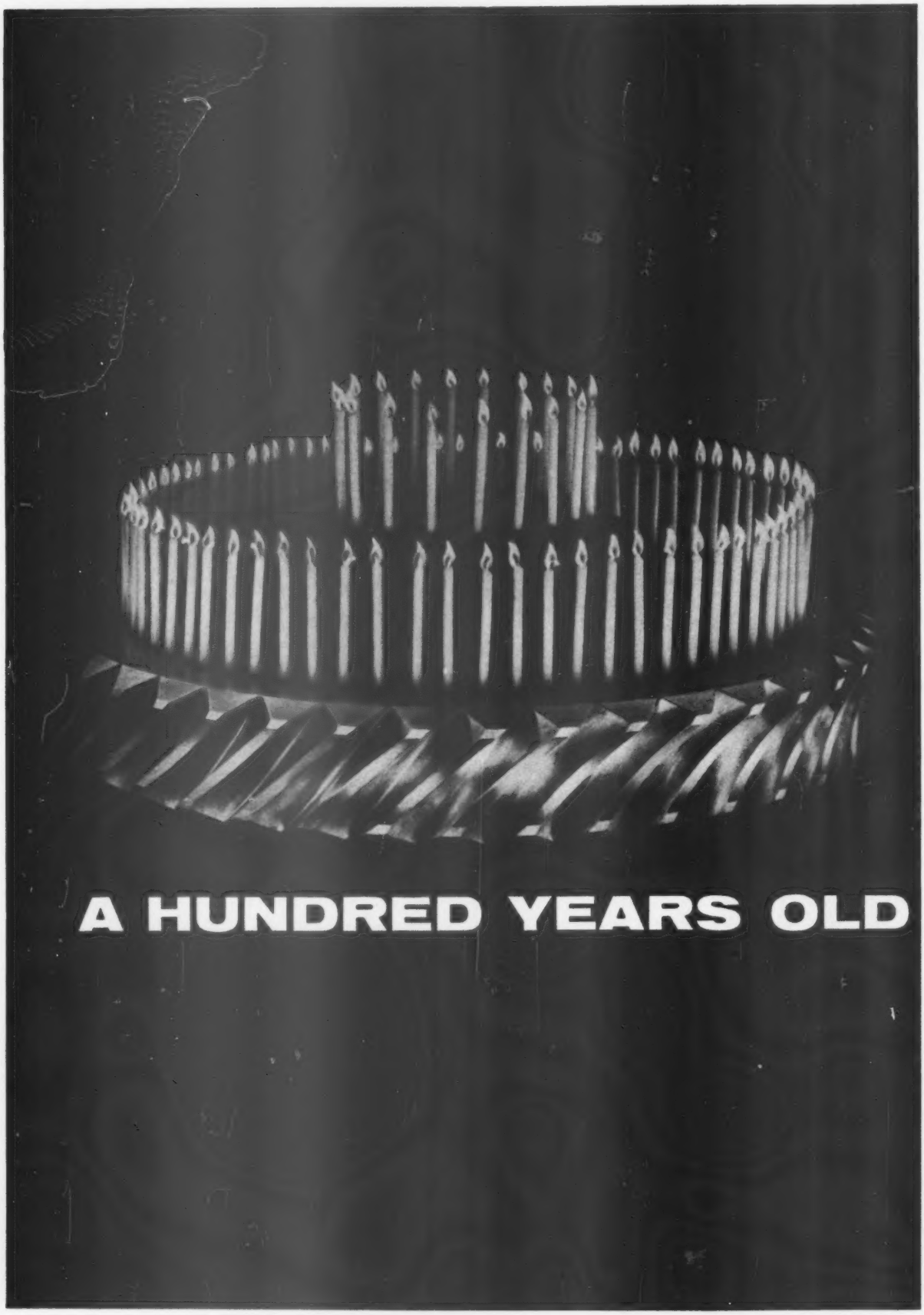
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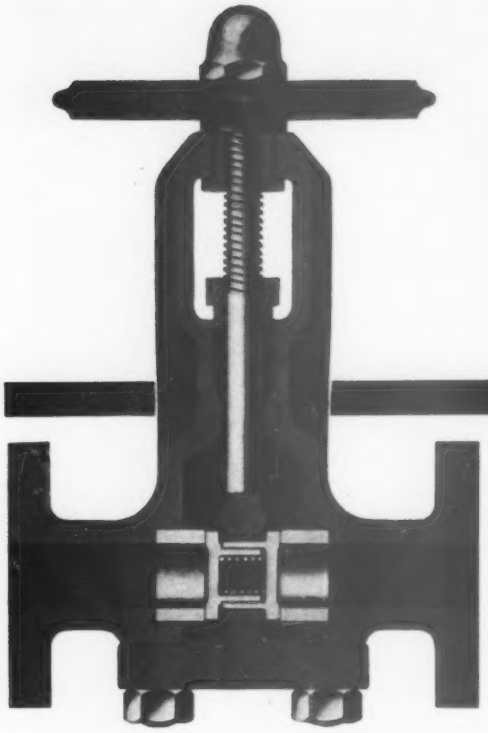

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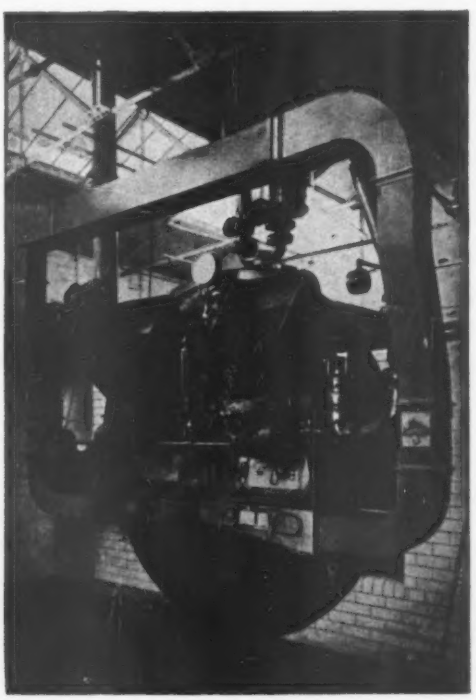

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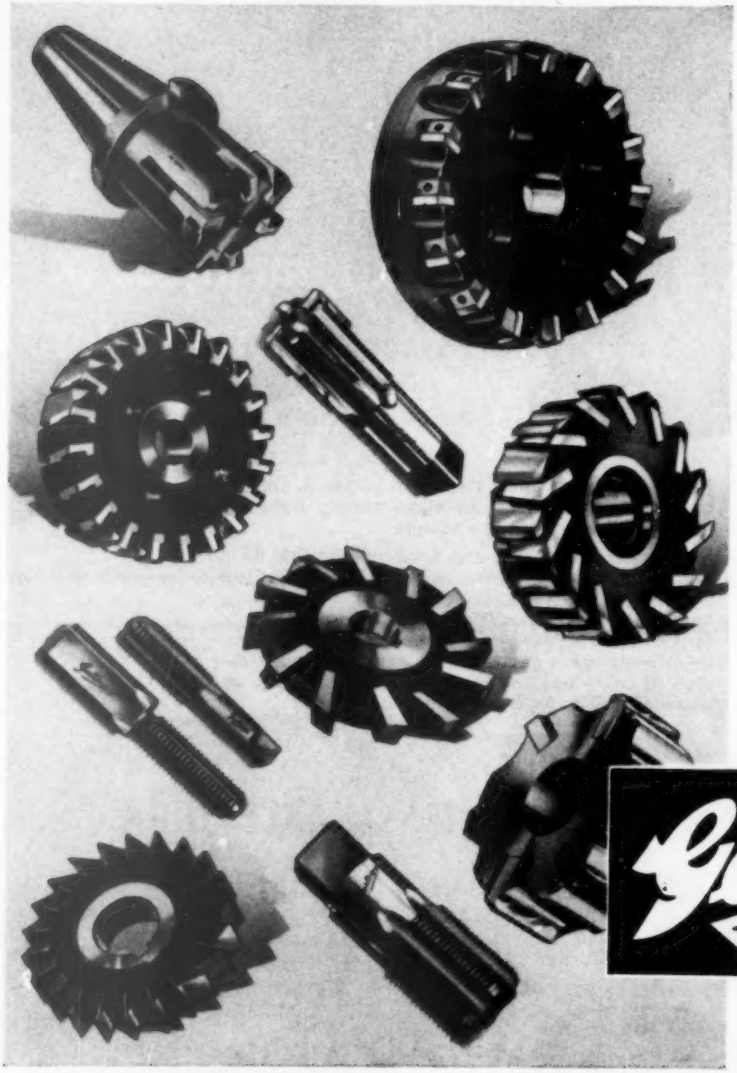

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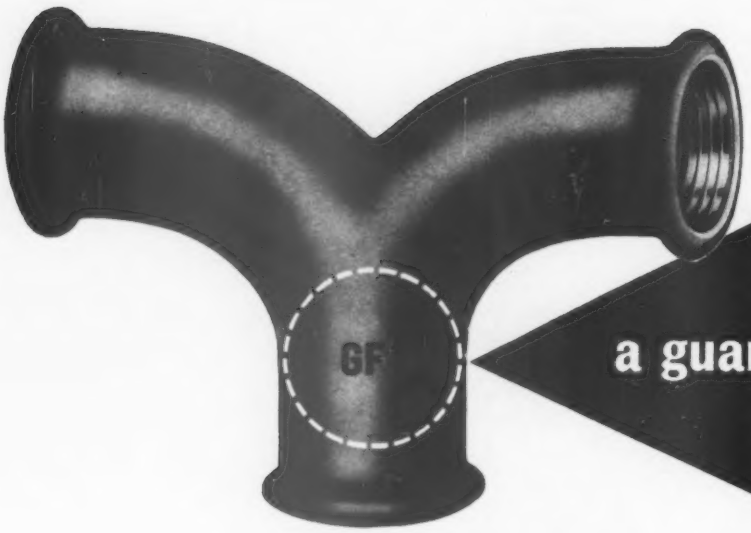

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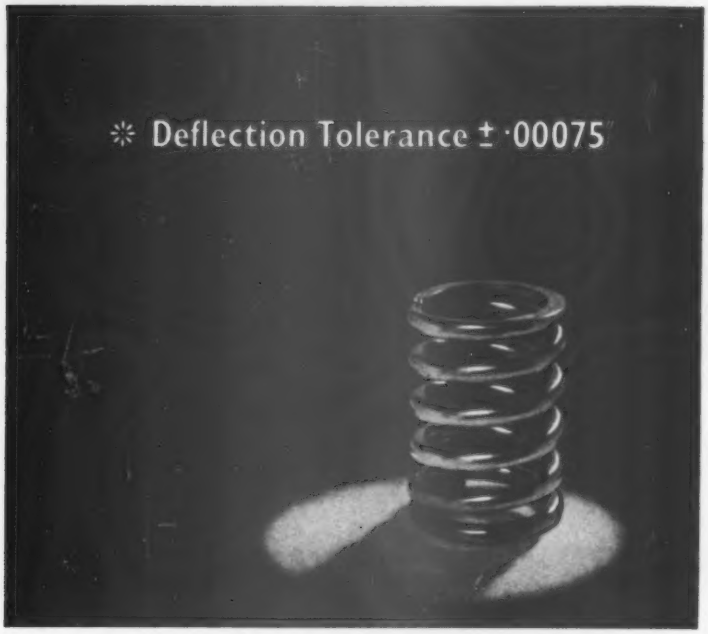

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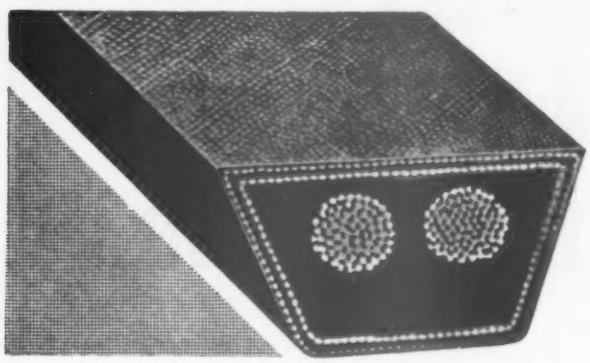

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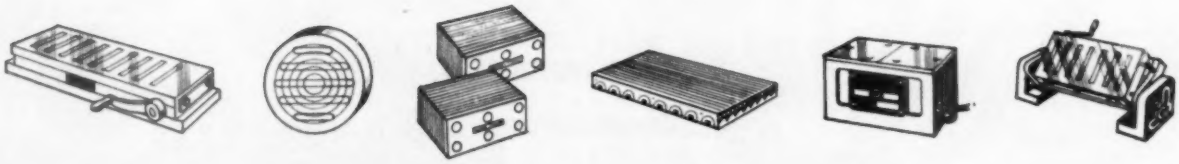

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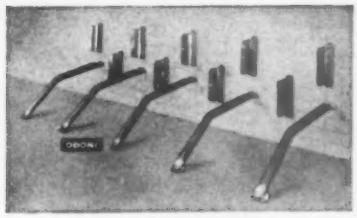

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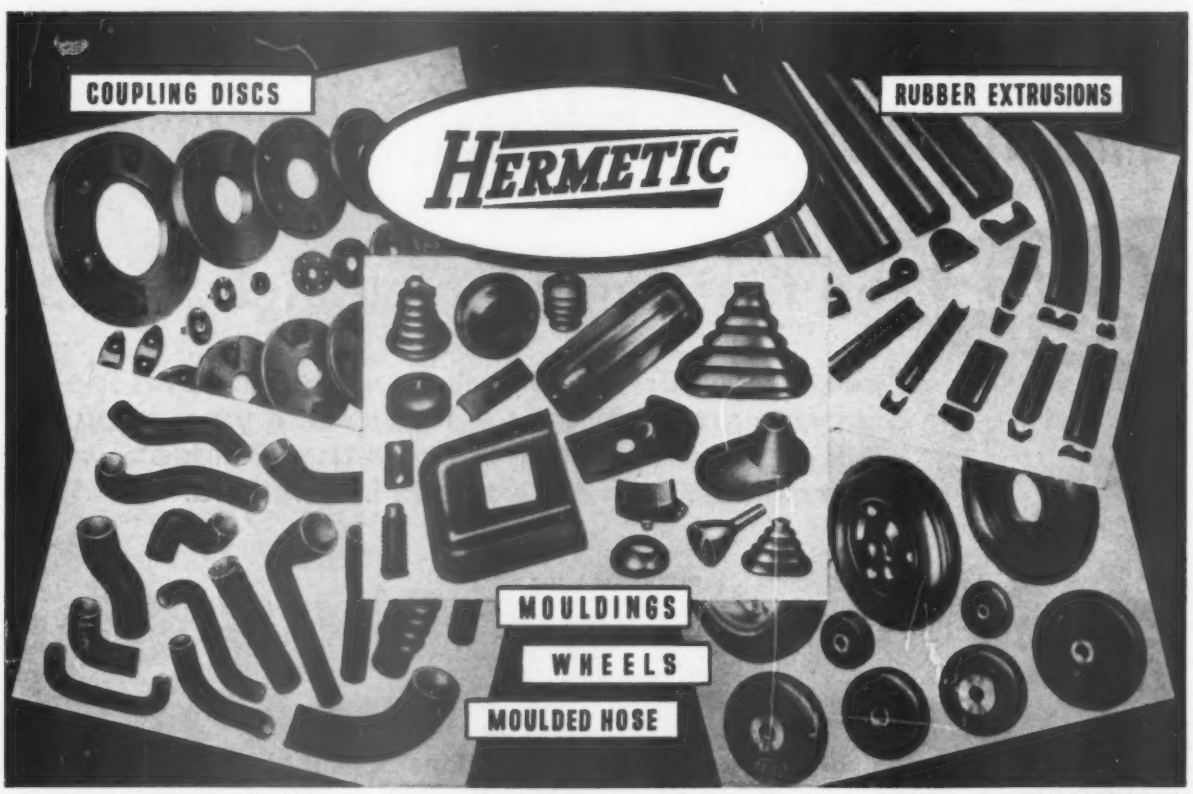

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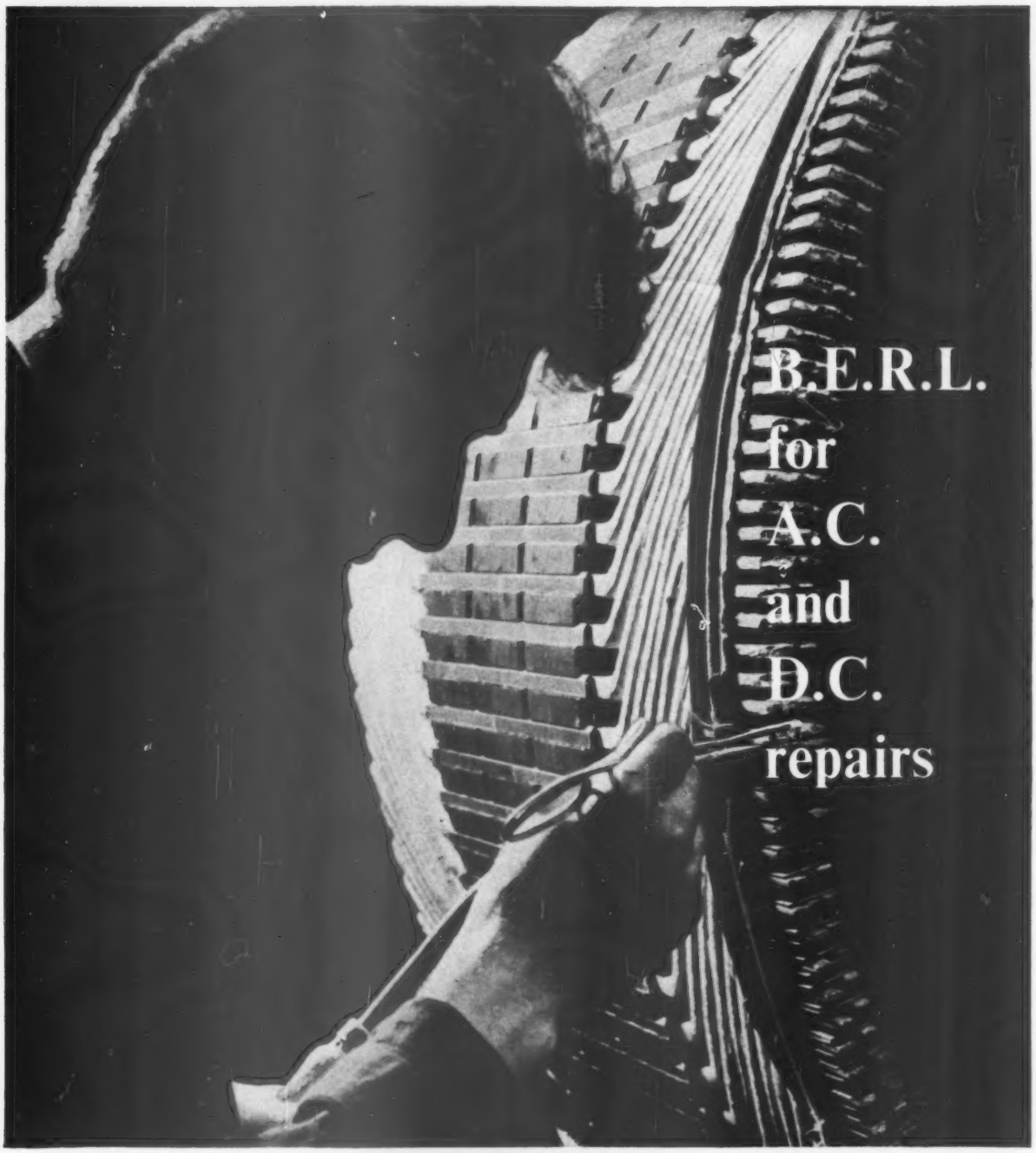

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Mechanical World

AND ENGINEERING RECORD

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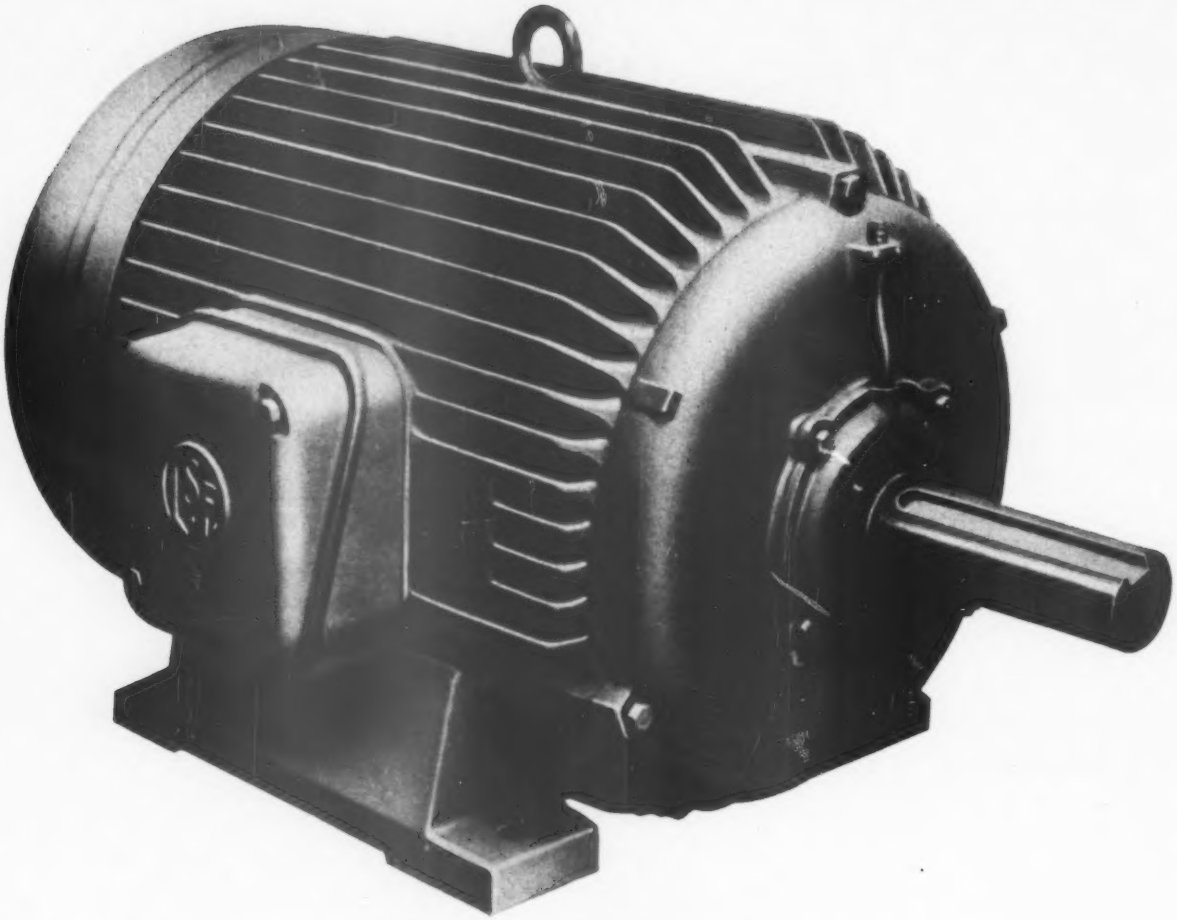

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Mechanical World —— December 1962

The Swing of the Balance

THE National Productivity Year which was inaugurated last month has the marks of a stitch in time, for although overall productivity in Britain is less than in the U.S.A. and Sweden, Britain is nevertheless among the three leaders. The disturbing feature, however, is that the rate of increase is less in Britain than elsewhere. Therefore to avoid being further overtaken it is necessary to increase the rate, and quickly. This cannot be done by order. It can only be achieved by a people who not only want the benefits it brings but who are willing to make it work by playing their part. This goes for everyone, right from Westminster to the man with the ash can. Constant engineering development and the work of the National Productivity Council are two vital factors which together have led to the present rate of increase, but they are not enough. To get the best result everyone affected must realize how dependent they are upon it and how their actions affect it, and this goes for Parliament, the Government, management, the trades unions, the universities and colleges, the research laboratories, and everyone else whose standard of living depends upon it, and that just about covers the whole working population from top to bottom and side to side.

The National Productivity Year is organized on the lines of conferences, study visits and the like, generally with the purpose of promoting awareness of how productivity evolves, where it becomes available, how it may be used, and the part that anybody and everyone can play in it to their own advantage—to show that there is in fact common ground, but upon which comparatively few people have as yet ventured. This getting together of people (or their ideas or thought) whose customary attitude to their work has the effect of keeping them apart, will have an effect similar but more developed to that which resulted from the productivity drive in the immediate post-war years when wide publication was given to the single aspect of American industrial know-how. There is much more to it now. In an industrial community productivity is the essential pre-requisite to all aspirations, private and public, and as such it must stand in the first place of national policy with only nihilism in opposition. There is no gainsaying the pressure with which the world is being driven into a changing pattern of existence. Fortunately at this juncture there seems to be a choice of drifting into the dreadful vision of Huxley's Brave New World or of consciously turning to a worthwhile and developing human existence. The swing of the balance might become noticeable in the National Productivity Year.

LOG SHEET

Year of Experiment

The Institution of Engineers and Shipbuilders in Scotland is launching a "Year of Experiment", aimed at reviving the status of the engineer in the community and at encouragement of the genius which is latent in the race and the industry. Mr Iain M. Stewart, President, regards this as a practical and valuable move which could have far reaching impact on industry and on social and civic affairs. In the 18th Century, when James Watt, the institution's patron, was working, men of genius in all callings cross fertilized their work. The institution has set out to interest such men in the work of the institution, with the object of again developing the climate of invention and enterprise which launched Scotland's Industrial Revolution.

The James Watt Exhibition at the Elmbank Street headquarters in October was used to initiate this idea and to attract the public and industrial leaders to the modernised premises, which will be used now for all sorts of meetings, conferences and professional purposes. The £200,000 exhibition covered every aspect of the James Watt life story, with portraits, papers, plans and model engines including the Newcomen engine on which Watt worked when perfecting his inventions. The Boulton and Watt enterprises were fully outlined and the background of famous men of Watt's period was also presented. About 80% of the material had never been seen before and no comparable presentation of Watt's work is ever likely to be gathered together in this form again. Public interest was encouraged by school and public periods; the 'Comet' model replica sailed up the Clyde to the Broomielaw where the party disembarked to visit the exhibition. A James Watt Dinner covered Watt's career with descendants of Watt and Boulton present and with the Minister of Labour, Mr John Hare, as principal guest.

That the institution is maintaining Watt's example was demonstrated by the papers presented on James Watt Day; they were on hovercraft (C. F. Morris of Denny Hovercraft Limited) and on the future of the diesel engine (C. C. Pounder of Harland and Wolff Limited).

Engineering Institutions Joint Council

Britain's leading bodies of professional engineers, with a combined membership of well over 200,000, are to work more closely together through the newly set up Engineering Institutions Joint Council under the chairmanship of Sir Kenneth Hague, LL.D., M.I.Mech.E. The purpose is to enable representatives of the bodies concerned to meet together to consider and take action upon matters of common interest relating to the advancement of engineering and the dissemination of knowledge in that field. They also aim to establish a sound and useful channel of communication and understanding between the professional engineers, the government, the public, and national and international bodies concerned with engineering. The bodies represented on the Council are the Royal Aeronautical Society, the Institutions of Chemical, Civil, Electrical and Gas Engineers, the Institute of Marine Engineers, the Institutions of Mechanical and Mining Engineers, the Institution of Mining and Metallurgy, and the Institutions of Municipal, Production, Radio, and Structural Engineers.

The Honorary Secretary is Mr K. H. Platt, M.B.E., B.Sc., M.I.Mech.E., and the office is at The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, SW1. Whitehall 7476.

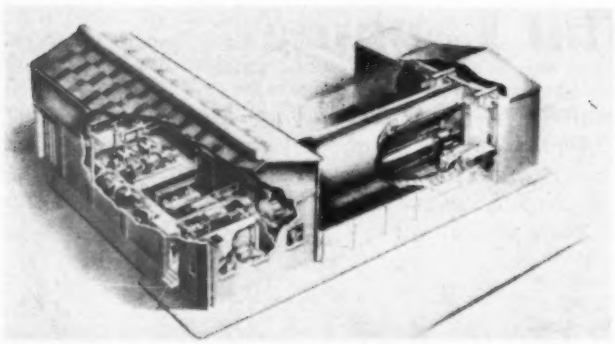
DUMMY CONTROL PANEL.—Layout of the instruments for the control panel of the first of the new generating sets at Drakelow C Power Station, which is to be completed in 1964. C.E.G.B. Midland Project Group consider that this full size model panel and dummy instruments by George Kent Limited will effect substantial savings in drawing office and design engineering time. Kent are supplying automatic control equipment and panel instrumentation worth over £500,000

Factory Communication

Communication is particularly important in a plant as large as the new Richard Thomas and Baldwins' Spencer Works at Llanwern, near Newport, for automatic functioning, the movement and storage of raw materials stocks, and the co-ordination of maintenance work.

Both general communications systems, and types for specialized tasks have been provided for plant operation purposes. In the former category are direct-wire telephone systems, AEI Clearcall loudspeaker systems to which access is available from a number of microphone stations, and AEI Clearcall loud-hailing systems. The heavy-duty direct-wire industrial telephone equipment is installed in most areas throughout the plant, linking key personnel associated with a particular operation. The loudspeaker systems enable instructions and information to be issued rapidly from any number of microphone stations in an operational area to all the personnel concerned who can then act rapidly on the information: the loudspeaker system also works in conjunction with the audio frequency loop communication system for cranes. The loud-hailer systems are provided for use over very large areas—such as the half-mile by quarter-mile stock yards—and are arranged so that all, or a particular part of an area can be selected to receive information; control is usually from a central point, often a control desk in the direct-wire system.

Specialized equipment provided by AEI includes apparatus to provide two-way communication with heavy mobile plant such as cranes and boom stackers where cable connection is not feasible, flameproof loud-speaking telephone equipment for areas where explosive gases may be present, a signalling system between



An artist's impression of the overspeed test house cut-away to indicate the disposition of the equipment. The annular construction of the test cell and the arrangement of the vacuum-tight sliding blast door are illustrated

the blast-furnace control centre and the turbo-blowers, and a personnel alarm system for the blast-furnace area.

Overspeed Test House

The new overspeed test house of Associated Electrical Industries Limited at Trafford Park, Manchester, is capable of testing a 1000 MW generator rotor. Turbine rotors (as distinct from generator rotors) can be run at a pressure much below atmospheric in order to limit the driving power required and also to limit the temperature rise due to windage. This dual testing facility is believed to be unique.

The building is a cylindrical test cell, closed at one end by a heavy sliding blast door and at the other end by the machine hall which houses the driving motor and gear box and other ancillary equipment. The cell is 65 ft long, 29 ft o.d. and has a bore of 19 ft. It is fabricated from 40 I-section steel rings, infilled with concrete and is designed to withstand the unlikely mishap of a burst rotor. It will supplement the present test house facilities which have operated safely for over 36 years.

Access is by a sliding blast door, which is electrically actuated and weighs 33 ton, and also by way of a small door in the drive end of the cell. A railway track, upon which the transporter bogies travel, extends from the factory manufacturing aisles to the interior of the cell. Each bogie is electrically driven.

The machine hall is set at right angles to the axis of the test cell with control room and the loading bay opposite. In the centre equipment is installed on three sides of a pit in the floor.

The 3350 hp, 750 rpm compensated, shunt-wound, main d.c. driving motor and its gearbox are mounted athwart the hall in front of the control room and in line with the axis of the cell. The Ward-Leonard motor-generator set is adjacent and the vacuum pumps and rotor-heating generator set are near the loading bay. Main components of both lubrication systems are in the oil tank pit.

Kanigen Nickel Deposition

A new £100,000 contract plant for electroless deposition by the Kanigen process has commenced production at the Midlands Works of Fescol Limited, at Brownhills, Staffordshire. The new plant occupies an initial area of approximately 9000 sq ft in a new 15,000 sq ft extension to the existing Fescol Works.

Kanigen is a process for chemically depositing nickel alloy and gives a uniform coating even on the most intricate shapes. It obviates the use of anodes. The thickness can be controlled to a close tolerance and the surface finish of the substrate metal is reproduced, there being no variation between peaks and troughs.

Most metals can be treated by the Kanigen process including mild steel, alloy and stainless steels, cast iron, copper and its alloys, aluminium and others. On ferrous metal, Kanigen, whilst providing protection against corrosion, also prevents contamination of products from iron in pumps, pipework and containers. Another important factor is that because of the deposit (500 VPN as deposited or 1,000 VPN after heat treatment) steel or aluminium can be used in place of expensive alloys.

The new Brownhills plant has an immediate work capacity of a total area in the order of 10,000 sq in. per hr for the thickness of deposits usually employed, and deposition tank capacities are accordingly provided.

Kanigen is a chemical reduction process which depends on the catalytic reduction of a nickel compound in solution by a reducing agent, sodium hypophosphite. The re-action takes place in a near-boiling solution and, in the case of many metals, is self-catalytic inasmuch as the existing surface of the metal to be plated will itself start deposition and a constant-rate growth will follow. The deposit is 92% nickel and 8% phosphorus and, as deposited, is of a non-crystalline glass-like structure. Heat treatment transforms it to a crystalline structure. It is resistant to organic liquids, hot or cold, and to many alkaline and neutral solutions.

Kanigen is a registered trade mark.

Hovercraft Machinery

The British United Airways passenger V.A.3 Hovercraft which was used during the summer on the Dee Estuary carried 3,765 fare paying passengers between Rhyl, Wales and Wallasey, England. In so doing it covered over 3,500 nautical miles. The machine is one of a series being produced by Vickers-Armstrongs Limited. It is powered by four Blackburn 603 Turmo gas turbines, two mounted at the rear and driving four blade Dowty Rotol propellers to give the Hovercraft a cruising speed of 70 mph and two to drive the two Dowty Rotol lift fans.

Hovercraft obtain their lift by a fan generated air cushion. The general requirements for this type of fan are low weight, flat head-flow characteristics, high efficiency, long life and low cost. The Dowty Rotol centrifugal impeller is of glass fibre and steel construction with a spoked central wheel reinforced with polyester resin, thus giving it a light rigid structure, a typical 11 ft dia impeller absorbing 400 hp at 430 rpm weighs 670 lb. Fans up to 12 ft dia absorbing 1500 hp and delivering 13,000 cu ft/sec with heads ranging from 50 to 90 lb/sq ft are at present under construction.

The characteristics of an impeller are designed to match a specific installation but, in general, efficiencies of the order of 80% are readily obtainable by the use of the appropriate aerofoil blading and careful aerodynamic design and wide variation in volume flow is possible with only a comparatively small change in head and efficiency.

Kinematics of Flat Lapping

An experimental machine uses an alternate working and truing cycle. Turned work which is out of parallel by amounts up to 0·005 in. can be lapped in a few minutes to a thickness variation not exceeding 0·0002 in. Small errors in machine alignment do not impair the accuracy of the work

By D. S. DUGDALE, A.M.I.Prod.E.

TO produce a flat surface by lapping, the lapping plate itself must have a perfectly flat surface. The classical way of making engineers' surface plates was to prepare three together. These were scraped or lapped until any pair gave perfect mating in any angular position on being rubbed together. Although this method can still be used for the rotating tables of lapping machines, it is commoner to use some method which allows the lap to be trued continuously or periodically without the need for removing it from the machine. This demands a generating process for truing rather than a copying process.

One such method is to have a fairly heavy ring, usually of cast iron, permanently resting on the lapping

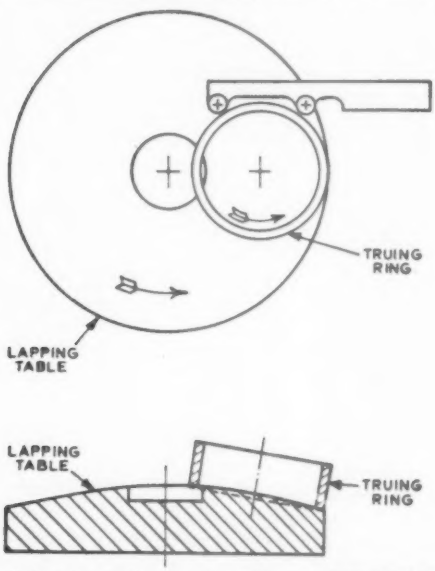


Fig. 1.—Truing ring used for correcting flatness of lapping machine table

plate, as shown in Fig. 1. Tangential friction force is taken by rollers in contact with the ring, so that the ring can rotate freely. This rotation ensures that the ring is lapped until its lower edge lies in a flat plane. The ring in turn wears down the lapping plate until they continuously make contact at all points around the edge of the ring. To comply with this condition, the only shape that can possibly be assumed by the lapping plate is a spherical shape. This principle is well illustrated by a tool sometimes used by turners for making ball-ended parts. This consists of a tube of bore somewhat less than the ball diameter, hardened and ground flat at one end. When the tool is pressed by hand against the rotating work, the work is shaved by the sharp inner edge of the tube until is assumes a perfectly spherical shape.

A truing ring can generate either a convex or concave spherical surface on the lapping plate. Moving the ring out towards the edge of the plate, or loading it by some means at its outer edge will tend to give preferential abrasion of the outer part of the lapping plate, producing convexity. Moving the ring towards the centre will tend to produce concavity. To get a flat surface, i.e. a spherical surface of infinite radius of curvature, the truing ring must be correctly adjusted. When work of the highest accuracy is to be carried out, the condition of the plate is best judged by lapping a test-piece of suitable diameter. Curvature of the test-piece surface is then assessed with an optical flat or an interferometer. This is preferable to testing the surface of the lapping plate itself, as a very slight convexity of the plate may be advantageous for producing perfectly flat work.

Frequently it is necessary to lap work on two sides to attain perfect parallelism, as for example, with slip gauges. As it is not very easy to correct errors in parallelism by lapping one side at a time, machines that lap both sides simultaneously between parallel lapping plates are used. The opposing laps may rotate about a

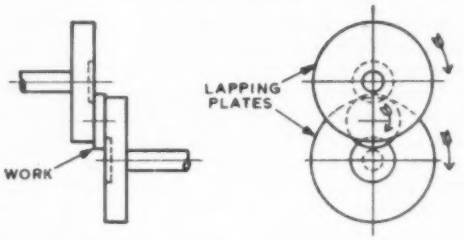


Fig. 2.—Offset lapping plates for lapping two-sided work

common axis or they may remain at rest while the work is oscillated between them. When one or other of the laps rotate, it may be possible to remove work-pieces and work holder and bring the laps into contact so that they can true each other. It can be seen that a surface of revolution is thus generated on both laps, but this surface need not be a true plane. Discs of mineral abrasive are sometimes used in such machines, when the process becomes one of honing rather than lapping. These discs may be trued by traversing a dressing tool over them in a straight line perpendicular to the axis of rotation.

A possible way of lapping two-sided work is to use two lapping plates mounted on offset shafts that are maintained exactly parallel, as shown in Fig. 2. To true

the lapping plates, the work-holder may be removed so that the plates may be brought into contact and lapped together. By itself, this process will not ensure that the plates become perfectly flat, or even conical, any more than two surface plates need be flat because they mate together. However, consider the state of affairs when a work-piece has been lapped for some time so that it makes contact with the lapping plates over its full width. As it rotates continuously, its faces must be surfaces of revolution. These faces may be flat or convex, but they cannot be concave. If they are convex, the radial profile of each lapping plate must be concave, as shown to an exaggerated degree in Fig. 3. During the next truing operation, mutual abrasion of the plates will remove this concavity. Therefore, during continuous lapping of work-pieces with periodic truing by lapping the plates together, the plates will become either flat or conical with a straight line of contact. In this state they will generate flat parallel surfaces on the work.

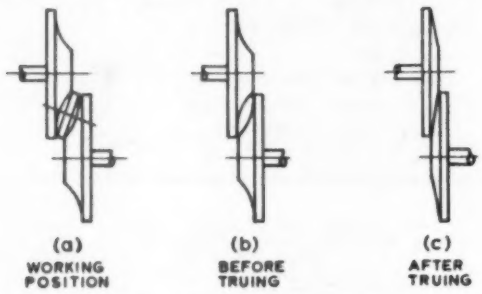


Fig. 3.—Diagram showing how concavity of lapping plates is eliminated by lapping them together

An experimental machine of this kind has recently been constructed at Sheffield University in collaboration with Firth-Brown Tools Limited. The machine was primarily designed for work 4 in. dia and ½ in. thick, and had lapping plates 9 in. dia. Trials have shown that work initially having a turned finish, and out of parallel by amounts up to 0·005 in. can be lapped flat in a few minutes so that the thickness variation in any one piece does not exceed 0·0002 in. It has been found that small errors in alignment of the machine shafts do not impair the accuracy of the work produced.

Preliminary Design of Gas Turbine Plant—XI

Power turbine calculations

By W. R. THOMSON, B.Sc.Tech.

11.1. Cycle calculation results

The following results are taken from the cycle calculations of Sect. 6, notably the table of results of Sect. 6.2.3. Throughout the turbine calculations the Section number will be followed in parenthesis by the relevant Section number of the turbine treatment of Sect. 9.

(9.7) $P_{in} = 26{\cdot}92$, $T_{in} = 829$, $P_{out} = 15{\cdot}69$, $T_{out} = 732$
$\delta T = 97$
$Q = 45{\cdot}00$, $\delta H = 25{\cdot}73$, $k = 0{\cdot}2649$, $\gamma = 0{\cdot}2649/(0{\cdot}2649 - 0{\cdot}0686) = 1{\cdot}35$, $\gamma/\eta_z(\gamma - 1) = 4{\cdot}320$, $q = 0{\cdot}00901$

11.2 (9.8)
$M_{out} = 0{\cdot}3$, $\gamma = 1{\cdot}35$, $V_a/\sqrt{T} = 19{\cdot}23$, $V_a = 19{\cdot}23\sqrt{732} = 520$

$$Q\sqrt{T}/AP = 0{\cdot}1915, \quad A_{out} = \frac{45{\cdot}00\sqrt{732}}{0{\cdot}1915 \times 15{\cdot}69} = 403{\cdot}4,$$

$$\tfrac{1}{4}\pi d_o^2 = \frac{403{\cdot}4}{0{\cdot}64} = 631$$

$d_o = 28{\cdot}36$, $d_i = 0{\cdot}6 \times 28{\cdot}36 = 17{\cdot}02$. If $u_i = 600$, $N = 137{,}600/17{\cdot}02 = 8090$, $\frac{1}{4}\pi d_i^2 = 227$.

11.3 (9.10)
$k\,\Delta T_{1\,max.} = (600/161)^2 + 6 \times 5{\cdot}2/12{\cdot}92 = 13{\cdot}9 + 2{\cdot}41 = 16{\cdot}3$

(9.11) $k\,\Delta T_{1\,max} = 1{\cdot}1 \times 16{\cdot}3 = 17{\cdot}9$

11.4 (9.12)

The maximum total of 34·2 for two stages is so much greater than the required $k\delta T$ of 25·73 that it would be advantageous to reduce the turbine speed rather than the alternative of reducing the α_{2i}'s. This would reduce the gearing which will in any case be necessary to drive the electricity generator. To find this speed

$$2.1\left\{(u_i/161)^2 + \frac{(u_i/100) \times 5{\cdot}2}{12{\cdot}92}\right\} = 25{\cdot}73$$ where the 2.1

is the sum of 1.1 + 1, i.e. allows for the basically assumed proportioning of $k\,\Delta T_1 + k\,\Delta T_2$.

$\therefore (u_i/161)^2 + u_i/248{\cdot}5 = 12{\cdot}24$
$(u_i/100)^2 + 1{\cdot}042\,(u_i/100) - 31{\cdot}75 = o$
$(u_i/100 + 6{\cdot}18)(u_i/100 - 5{\cdot}14) = o$, $\therefore u_i = 514$.
$N = 8090 \times 514/600 = 6930$
$k\,\Delta T_2 = (514/161)^2 + 5{\cdot}14 \times 5{\cdot}2/12{\cdot}92 = 10{\cdot}20 + 2{\cdot}07 = 12{\cdot}27$
$k\,\Delta T_1 = 25{\cdot}73 - 12{\cdot}27 = 13{\cdot}46$.

11.5 (9.13.1)
$M_{a\,in} = 0{\cdot}3$, $Q\sqrt{T}/AP = 0{\cdot}1915$, $A_{in} = \dfrac{45{\cdot}00\sqrt{829}}{0{\cdot}1915 \times 26{\cdot}92} = 251{\cdot}4$

$\frac{1}{4}\pi\, d_o^2 = 227 + 251{\cdot}4 = 478{\cdot}4$, $\therefore d_o = 24{\cdot}67$.

(9.13.2)
$\Delta T_1 = 13{\cdot}46/0{\cdot}2649 = 50{\cdot}8$, $\therefore T_{out} = 829 - 51 = 778$
$P_{out} = 26{\cdot}92\,(778/829)^{4{\cdot}220} = 26{\cdot}92 \times 0{\cdot}762 = 20{\cdot}52$
$(V_a/\sqrt{T})_{out} = 19{\cdot}23$, $\therefore V_a = 19{\cdot}23\sqrt{779} = 526$

$$(Q\sqrt{T}/AP)_{out} = 0{\cdot}1915, \quad \therefore A_{out} = \frac{45{\cdot}00\sqrt{779}}{0{\cdot}1915 \times 20{\cdot}52} = 320$$

$\frac{1}{4}\pi d_o^2 = 227 + 320 = 547$ $\therefore d_o = 26{\cdot}40$.

First Stage	Last Stage
11.6 (9.14)	
$d_{m\ out} = \frac{1}{2}(17{\cdot}02 + 26{\cdot}40)$	$d_{m\ out} = \frac{1}{2}(17{\cdot}02 + 28{\cdot}36)$
$= 21{\cdot}71$	$= 22{\cdot}69$
$u_{m\ out} = 514 \times 21{\cdot}71/17{\cdot}02$	$u_{m\ out} = 514 \times 22{\cdot}69/17{\cdot}02$
$= 656$	$= 685$
$d_{or} = 0{\cdot}995 \times 26{\cdot}40 = 26{\cdot}27$	$d_{or} = 0{\cdot}995 \times 28{\cdot}36 = 28{\cdot}22$
$d_{mr} = 0{\cdot}995 \times 21{\cdot}71 = 21{\cdot}60$	$d_{mr} = 0{\cdot}995 \times 22{\cdot}69 = 22{\cdot}58$
$u_{mr} = 0{\cdot}995 \times 656 = 653$	$u_{mr} = 0{\cdot}995 \times 685 = 682$
$h_r = 21{\cdot}60 - 17{\cdot}02 = 4{\cdot}58$	$h_r = 22{\cdot}58 - 17{\cdot}02 = 5{\cdot}56$
11.7 (9.15)	
$\text{Tan}\,\alpha_{2t} = \frac{45{,}080 \times 13{\cdot}46 - 0{\cdot}98 \times 656^2}{1{\cdot}98 \times 514 \times 526}$	$\text{Tan}\,\alpha_{2t} = \frac{45{,}080 \times 12{\cdot}27 - 0{\cdot}98 \times 685^2}{1{\cdot}98 \times 514 \times 520}$
$= \frac{606{,}500 - 422{,}000}{535{,}000}$	$= \frac{553{,}000 - 460{,}000}{529{,}000}$
$= \frac{184{,}500}{535{,}000} = 0{\cdot}345$	$= \frac{93{,}000}{529{,}000} = 0{\cdot}1758$
$\text{Tan}\,\alpha_{ot} = \frac{606{,}500 - 514 \times 526 \times 0{\cdot}345}{267{,}500}$	$\text{Tan}\,\alpha_{ot} = \frac{553{,}000 - 514 \times 520 \times 0{\cdot}1758}{264{,}500}$
$= \frac{606{,}500 - 93{,}300}{267{,}500}$	$= \frac{553{,}000 - 46{,}950}{264{,}500}$
$= \frac{513{,}200}{267{,}500} = 1{\cdot}920$	$= \frac{506{,}050}{264{,}500} = 1{\cdot}913$
$\text{Tan}\,\alpha_{1t} = 1{\cdot}920 - \frac{514}{0{\cdot}99 \times 526}$	$\text{Tan}\,\alpha_{1t} = 1{\cdot}913 - \frac{514}{0{\cdot}99 \times 520}$
$= 1{\cdot}920 - 0{\cdot}987 = 0{\cdot}943$	$= 1{\cdot}913 - 0{\cdot}999 = 0{\cdot}914$
$\text{Tan}\,\alpha_{2t} = 0{\cdot}345 + 514/526$	$\text{Tan}\,\alpha_{2t} = 0{\cdot}1758 + 514/520$
$= 0{\cdot}345 + 0{\cdot}977 = 1{\cdot}322$	$= 0{\cdot}1758 \times 0{\cdot}988 = 1{\cdot}164$
$\alpha_1 = 43{\cdot}3, \alpha_2 = 52{\cdot}9, (\alpha_{2t} = 19{\cdot}0)$	$\alpha_1 = 42{\cdot}4, \alpha_2 = 49{\cdot}35, (\alpha_{2t} = 9{\cdot}97)$
11.8 (9.16)	
$i = o, \beta_1 = \alpha_1 = 43{\cdot}3$	$i = o, \beta_1 = \alpha_1 = 42{\cdot}4$
$\beta_2 = 10 + 0{\cdot}867 \times 52{\cdot}9 = 55{\cdot}9$	$\beta_2 = 10 + 0{\cdot}867 \times 49{\cdot}35 = 52{\cdot}8$
$\theta = 43{\cdot}3 + 55{\cdot}9 = 99{\cdot}2$	$\theta = 42{\cdot}4 + 52{\cdot}8 = 95{\cdot}2$
11.9 (9.17)	
$d_i/d_{or} = 17{\cdot}02/26{\cdot}27 = 0{\cdot}647$ (uncooled blades)	$d_i/d_{or} = 17{\cdot}02/28{\cdot}22 = 0{\cdot}603$ (uncooled blades)
$(s/c)_t = 0{\cdot}518$	$(s/c)_t = 0{\cdot}49$
$(t/c)_t = 0{\cdot}159$	$(t/c)_t = 0{\cdot}15$
$(t_o/t_i)_u = 0{\cdot}378$	$(t_o/t_i)_u = 0{\cdot}35$
11.10 (9.18.1)	
$V_{a\ in} = 0{\cdot}99 \times 526 = 521$	$V_{a\ in} = 0{\cdot}99 \times 520 = 515$
$\delta T_{va} = \frac{521^2}{90{,}160 \times 0{\cdot}2649} = 11{\cdot}4$	$\delta T_{va} = \frac{515^2}{90{,}160 \times 0{\cdot}2649} = 11{\cdot}1$
$T_b = 829 - 11{\cdot}4\,(1{\cdot}9^2 - 0{\cdot}87 \times 0{\cdot}923^2)$	$T_b = 779 - 11{\cdot}1\,(1{\cdot}89^2 - 0{\cdot}87 \times 1{\cdot}153^2)$
$= 829 - 11{\cdot}4\,(3{\cdot}61 - 0{\cdot}74)$	$= 779 - 11{\cdot}1\,(3{\cdot}60 - 1{\cdot}13)$
$= 829 - 32{\cdot}7 = 796$	$= 779 - 27{\cdot}4 = 752$
11.11 (9.19) **(Using Calculation)**	
t = 50,000 hr, Nimonic 90.	t = 50,000 hr. Nimonic 90.
$\frac{1450 - T_b}{t^{0{\cdot}0445}} = \frac{654}{1{\cdot}619} = 404$	$\frac{1450 - T_b}{t^{0{\cdot}0445}} = \frac{698}{1{\cdot}619} = 431$
For F_s, $m = 1{\cdot}865$, $n = 1{\cdot}99$	*For* F_s, $m = 1{\cdot}865$, $n = 1{\cdot}99$
$F_s = \left(\frac{404}{73{\cdot}5}\right)^{1{\cdot}99} = 5{\cdot}5^{1{\cdot}99} = 29{\cdot}7$	$F_s = \left(\frac{431}{73{\cdot}5}\right)^{1{\cdot}99} = 5{\cdot}86^{1{\cdot}99} = 33{\cdot}8$
For F_f, $m = 1{\cdot}168$, $n = 0{\cdot}934$	*For* F_f, $m = 1{\cdot}168$, $n = 0{\cdot}934$
$F_f = \left(\frac{404}{14{\cdot}75}\right)^{0{\cdot}934} = 27{\cdot}4^{0{\cdot}934} = 22{\cdot}0$	$F_f = \left(\frac{431}{14{\cdot}75}\right)^{0{\cdot}934} = 29{\cdot}2^{0{\cdot}934} = 23{\cdot}4$

First Stage	Last Stage
11.12 (9.21.1) **(Straight Taper)**	**(Straight Taper)**
$t_o/t_i = 0{\cdot}378,\ d_i/d_o = 0{\cdot}647$	$t_o/t_i = 0{\cdot}35,\ d_i/d_o = 0{\cdot}603$
$\phi = 1 - \frac{0{\cdot}622}{3} \times \frac{2{\cdot}647}{1{\cdot}647} = 1 - 0{\cdot}334$	$\phi = 0{\cdot}648$ (for limiting case).
$= 0{\cdot}666$	
11.13 (9.22)	
$f_c = 0{\cdot}990 \times 0{\cdot}666 \times \frac{4{\cdot}58}{21{\cdot}60} \times 6{\cdot}53^2 = 5{\cdot}96$	$f_c = 0{\cdot}990 \times 0{\cdot}648 \times \frac{5{\cdot}56}{22{\cdot}58} \times 6{\cdot}82^2 = 7{\cdot}36$
11.14 (9.23) (**Assume** $n = 5$)	**Assume** $n = 5$
$(F_f/n)^2 = (22{\cdot}0/5)^2 = 19{\cdot}4$	$(F_f/n)^2 = (23{\cdot}4/5)^2 = 21{\cdot}9$
$\frac{4F_s(F_s - f_c)}{(F_f/n)^2} = \frac{4 \times 29{\cdot}7 \times 23{\cdot}74}{19{\cdot}4} = 145{\cdot}2$	$\frac{4F_s(F_s - f_c)}{(F_f/n)^2} = \frac{4 \times 33{\cdot}8 \times 26{\cdot}44}{21{\cdot}9} = 163{\cdot}2$
$f_b = \frac{19{\cdot}4}{2 \times 29{\cdot}7}(\sqrt{146{\cdot}2} - 1) = 3{\cdot}63$	$f_b = \frac{21{\cdot}9}{2 \times 33{\cdot}8}(\sqrt{164{\cdot}2} - 1) = 3{\cdot}82$
11.15 (9.25)	
$b = 1420 - 9{\cdot}3 \times 99{\cdot}2 = 498$	$b = 1420 - 9{\cdot}3 \times 95{\cdot}2 = 535$
$a = \frac{272 - 99{\cdot}2}{148} = 1{\cdot}168$	$a = \frac{272 - 95{\cdot}2}{148} = 1{\cdot}193$
(9.26)	
$\text{Tan}\ \zeta = \frac{1}{2}(\tan 55{\cdot}9 - \tan 43{\cdot}3)$	$\text{Tan}\ \zeta = \frac{1}{2}(\tan 52{\cdot}8 - \tan 42{\cdot}4)$
$= \frac{1}{2}(1{\cdot}477 - 0{\cdot}943) = 0{\cdot}267$	$= \frac{1}{2}(1{\cdot}318 - 0{\cdot}914) = 0{\cdot}202$
$1 + \tan^2\zeta = 1{\cdot}0713 \quad \zeta = 14{\cdot}94$	$1 + \tan^2\zeta = 1{\cdot}0408 \quad \zeta = 11{\cdot}4$
(9.27)	
$c^3 = \frac{498 \times 1{\cdot}0713 \times 45{\cdot}00 \times 13{\cdot}46 \times 4{\cdot}58 \times 0{\cdot}518}{1{\cdot}59^{1{\cdot}169} \times 6530 \times 17{\cdot}02 \times 3{\cdot}63}$	$c^3 = \frac{535 \times 1{\cdot}0408 \times 45{\cdot}00 \times 12{\cdot}27 \times 5{\cdot}56 \times 0{\cdot}49}{1{\cdot}5^{1{\cdot}193} \times 6820 \times 17{\cdot}02 \times 3{\cdot}82}$
$= 1{\cdot}105,\ \therefore\ c = 1{\cdot}05$	$= 1{\cdot}165,\ \therefore\ c = 1{\cdot}08$
11.16 (9.28)	
$\omega = 1{\cdot}05 \cos 14{\cdot}94 = 1{\cdot}015$	$\omega = 1{\cdot}08 \cos 11{\cdot}4 = 1{\cdot}059$
$\omega_s = 2\frac{1}{2} \times 1{\cdot}015 = 2{\cdot}71$	$\omega_s = 2\frac{1}{2} \times 1{\cdot}059 = 2{\cdot}82$
$L = 2{\cdot}71 + 2{\cdot}82 = 5{\cdot}53$ in.	

To be continued.

Lubricants in the Antarctic

Development trials and user reports form an important part of the Rocol research programme and the existence of British survey bases in Antarctica presents a unique opportunity for extended trials of Rocol lubricants under the most exacting conditions. The first report received from the British Antarctic survey base, Halley Bay, Coatsland, records that Rocol Molyspeed was used as an additive in the sump of the six cylinder Chrysler engine fitted in one Muskeg and that after treatment the engine ran noticeably easier and was much easier to start. During winter, preheating is necessary before starting and it is here that the use of molybdenum disulphide was most beneficial, the heating time required to achieve full cranking speed being considerably reduced. The Molyspeed engine oil additive is considered to be successful enough for it to be continued.

Rocol Molysil 33 was used on motors for the Meteorological Department. These are six watt synchronous motors with plain bearings driving a fan for ventilating remote reading thermometers. Three motors are running continuously throughout the year. Trouble had been experienced and it was thought that lubricants previously tried were not able to stand the low temperatures which occur in winter. The range of temperatures is usually about 0° to −50°C throughout the year. With normal lubricants the bearings soon ran dry causing damage to the shaft. With the Rocol product, running times were extended slightly and no damage was experienced on the shafts even when the lubricant had dried and choked the bearing. This resulted in considerably extended motor life.

Indoor Terminal Box

Latest addition to the range of indoor terminal boxes produced by Cable Division of Associated Electrical Industries Limited is a horizontal type for single core paper insulated lead sheathed (PL) unarmoured cable for earthed electrical power systems. The boxes are suitable for incoming cables, for 3·3 kV, 6·6 kV and 11 kV working pressure. The outgoing connexion is a copper rod in a cream glazed porcelain insulator. The copper rod is screwed and sweated into the cable connector. The new terminal box is available in a range suitable for 0·3, 0·5 and 1·0 sq in. conductor sizes in each of the three voltages. The boxes are marketed by Distribution Equipment Sales Department, AEI Cable Division, 145 Charing Cross Road, London WC2.

Hydraulic Accumulators

The inclusion of an accumulator in even the simplest hydraulic circuits often offers specific advantages, particularly where peak power demands are intermittent or variable. The most commonly used accumulators are gas-loaded cylindrical types, either separated or non-separated. The compression ratio of the accumulator can readily be adjusted by the use of auxiliary gas bottles. Basic accumulator working principles are discussed in this article

THE chief application of a hydraulic accumulator is as a power source to meet peak demands by the system, thus effecting considerable economies by enabling a smaller pump to be employed. The pump may be run continuously and off-loaded when not actually required to supply pressure, or shut down completely after charging the accumulator and subsequently re-started, as necessary, at a pre-determined pressure level to maintain the accumulator pressure. The mode of coupling depends entirely on the particular application and the system demand. Thus, for example, the accumulator may supply the bulk of the system requirements when the main purpose of the pump operating on a 'stop-start' basis is simply to keep the accumulator charged above the required minimum pressure; or the accumulator may be a secondary source of power where the average demand is met economically by the pump with higher intermittent demand extracted from the accumulator.

In addition, accumulators may be used for a variety of other purposes. The accumulator may be used as a source of power for emergency operation of a system in the event of pump failure, or during a changeover from one system to another. The size of the accumulator is then chosen to provide the required number of duty cycles with or during 'pumpless' operation. An accumulator also possesses the characteristic of acting as a damper to hydraulic shock. It may thus be introduced specifically into a high-pressure high-duty system purely to act as a shock-suppressor. Where the accumulator is used as a 'working' component in the system the same characteristics apply, which may again favour its selection. An accumulator is also a useful source of fluid make-up to compensate for differences in fluid volume operating a piston from the plain end and the rod end, or to accommodate changes in fluid volume due to thermal contraction or expansion.

Other applications of accumulators include use as holding devices, for synchronization of ram movements by acting as flow equalizers, supplying the increased pressure required in dual-pressure circuits, as dampers in air-hydraulic circuits, etc.; and also to compensate for internal leakage in the circuit. In the latter case this is normally concerned with high pressure circuits where these high pressures may have to be held for a considerable period of time. Some leakage past the ram or valve piston will be inevitable and an accumulator provides a useful and simple method of preventing loss of pressure.

Nearly all modern hydraulic accumulators are of the gas-loaded type, although use is still made of weight-loaded accumulators where water is used as the fluid and fluid volume is large. Many weight-loaded accumulators built in the last century are still working and designs based on the original working principle are still made and capable of giving economic service with water-hydraulic systems. Small weight-loaded accumulators, too, are sometimes used purely as shock suppressors.

Gas-loaded accumulators can be sub-divided, basically, into two main types—non-separated accumulators where the gas charge is in direct contact with the fluid; and separated types where gas charge and fluid are separated by a diaphragm, flexible bag or piston. Of the separated types, free piston accumulators are the most common for industrial hydraulic systems.

The non-separated gas-loaded accumulator consists of a pressure vessel or bottle which is invariably mounted vertically with a fluid discharge port at the bottom and a gas charge valve at the top—Fig. 1. Fluid is introduced into the vessel and the accumulator then pressurized by introducing a charge of compressed gas at a pre-determined pressure. As fluid is withdrawn from the accumulator the gas will expand to fill the space left by the fluid extracted, and the pressure will drop slightly in consequence. When fluid is pumped back into the accumulator the gas will be compressed, resulting in a slight increase in pressure.

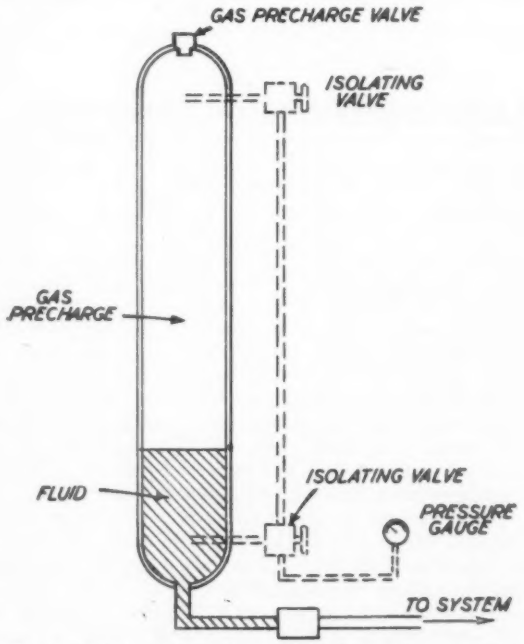


Fig. 1.—Typical proportions of non-separated gas-loaded accumulator

The relationship is normally isothermal and so the following general formulae apply—

$$P_h V_h = P_l V_l$$
$$V_f = V_g (P_h/P_l - 1)$$
$$V_g = V_f/(P_h/P_l - 1)$$
$$\text{Nominal (mean) pressure} = \tfrac{1}{2}(P_h + P_l)$$
$$\text{Pressure variation} = 100 \times (P_h + P_l)/P_h\,\%$$

where P_h = pressure at high fluid level
P_l = ,, ,, low ,, ,,
V_h = volume ,, high ,, ,,
V_l = ,, ,, low ,, ,,
V_f = effective fluid capacity of accumulator
V_g = volume of gas at high fluid level

The difference in pressure between maximum value (fluid level at its highest) and minimum value (fluid level at its lowest) is thus obviously related to the compression ratio, or more specifically, the ratio of the gas to the fluid volume. Thus for a 10% variation in pressure between 'high' and 'low' fluid levels, a gas to liquid ratio of 9:1 is required. In practice the liquid volume in the accumulator would normally be increased to provide a 'reserve' ensuring that the accumulator is never emptied completely, and so gas is not introduced into the system itself. Thus the total volume of the bottle is larger than the geometry required for the design compression ratio (or gas: fluid ratio). Typical figures for a 10% pressure variation, in fact, would be a total bottle volume of some 10·5 to 11 times the *effective* or usable fluid volume (the nominal fluid capacity of the accumulator).

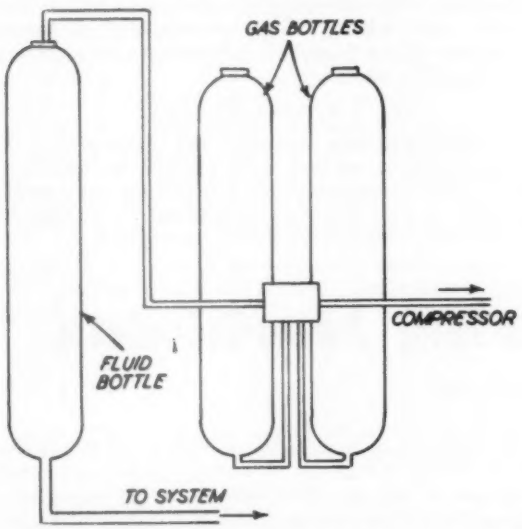


Fig. 2.—Non-separated gas-loaded accumulator with auxiliary gas bottle

Once charged, such an accumulator can be cycled without further attention since no gas is lost during cycling. A proportion of gas initially introduced will, of course, be absorbed by the fluid and the amount of absorption will vary slightly with the fluid level. This, however, has a negligible effect. The gas charge is usually air or nitrogen, neither of which present any problems in miscibility or solution with normal oil fluids, or with water. In the latter case an oil layer is sometimes employed on top of the water as a barrier, but this does not appear necessary. Absorption of gas in direct contact with the fluid is limited to a relatively shallow depth below the actual common surface, with no penetration of the gas through the fluid. Thus the non-separated type of accumulator is no more prone to introduce gas into the hydraulic lines than the separated type, provided it is properly designed. If the low level of liquid is too low, for example or the fluid outlet pipe badly positioned, vortex action in the fluid could partially open the oil port for the entry of gas.

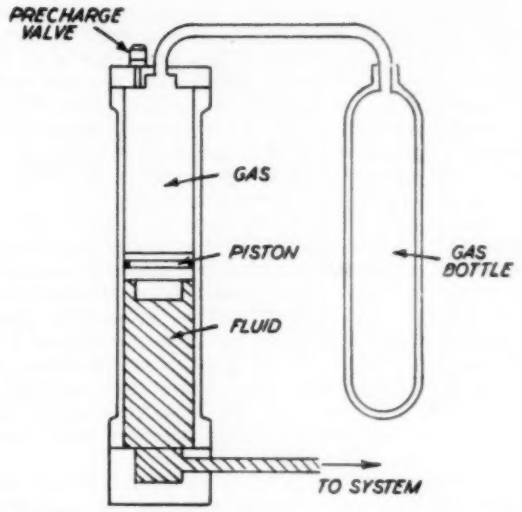


Fig. 3.—Simple free-piston separated accumulator and auxiliary gas bottle

It will be appreciated that with this type of accumulator the actual volume of the bottle is large compared with the useful fluid volume contained. The shape is invariably long and narrow (to reduce the contact area of gas and fluid) which, with vertical mounting, does not normally represent any particular space problems. A simple method of increasing the gas volume is to couple the bottle to a separate gas bottle—Fig. 2. This then enables the fluid volume in the original bottle to be increased and maintain the same compression ratio; or the pressure difference during operation to be reduced for the same (initial) fluid volume. Alternatively, fluid volume can be increased by connecting two or more accumulators in parallel, with or without auxiliary gas bottles, as required. The system is, therefore, extremely flexible both as regards capacity and pressure regulation.

Piston-type accumulators employ a free piston as a separator in a pressure cylinder. One end of the cylinder is then charged with compressed gas, and fluid pumped into the other end—Fig. 3. Again such accumulators are normally mounted vertically, although horizontal mounting can be used if necessary. In the case of systems which discharge the accumulator completely then vertical mounting is necessary unless the design incorporates a liquid seal or positive shut-off which prevents gas leaking past the piston seal into the hydraulic lines with no pressure in the hydraulic system. Simple piston-type accumulators which are required to discharge (fluid) completely are normally provided with a spigot on the piston entering a matching cylindrical hole in the fluid head at the end of the stroke to give 'dashpot' damping and thus eliminate hydraulic shock when the piston is brought to rest at the end of its stroke.

The initial inflation pressure of a typical piston-type

accumulator which is worked continuously is usually chosen so that it corresponds to the lower or cut-in value of the system working pressure. This gives the greatest swept volume over the working pressure range and thus reduces the number of pressure cycles. Where the accumulator is only being used intermittently, lower inflation pressures and higher compression ratios can be used. Compression ratios are generally of the order of 1·5:1 to 3:1, depending on the application.

Where a low compression ratio is required (i.e. a substantial increase in gas volume to reduce the pressure difference), the accumulator can be coupled to a separate gas bottle, as with non-separated types. Alternatively, some designs (e.g. Fairey) provide an annular space outside the cylinder liner for increased gas volume. This liner can be quite thin for the pressure on the inside and outside is the same and such accumulators can offer a considerable economy in weight for an equivalent fluid capacity and compression ratio, compared with simple piston-type accumulators.

The fluid capacity required for a given working pressure is normally calculated on the basis of isothermal conditions, according to the formula

$$V_2 = (P_1 V_1/P_2) - (P_1 V_1/P_3)$$

where V_1 = total gas volume
V_2 = fluid capacity required
P_1 = initial gas precharge pressure
P_2 = minimum working pressure of system
P_3 = maximum " " " "

The fluid capacity chosen is normally slightly greater than the maximum system demand as this normally results in the most economic size of accumulator.

When the accumulator is connected to an auxiliary gas bottle the following relationships apply—

$$P_1(V_1+V_4) = P_2(V_2+V_4) = P_3(V_3+V_4)$$
$$V_0 = V_2 - V_3$$

where P_1 = precharge pressure of gas
P_2 = minimum working pressure
P_3 = maximum working pressure
V_0 = fluid volume required
V_1 = accumulator capacity or swept volume
V_2 = volume of gas at pressure P_2
V_3 = volume of gas at pressure P_3
V_4 = volume of gas bottle

Without the auxiliary gas bottle, $V_4 = o$ and

$$P_1V_1 = P_2V_2 = P_3V_3$$

If it is required to discharge the fluid completely from the accumulator the following relationship applies—

$$P_1(V_1+V_4) = P_3(V_3+V_4)$$
$$V_0 = V_1 - V_3$$

Also, where the maximum and minimum working pressure requirements are such that the volume of the auxiliary gas bottle required is small compared with the fluid volume, it is normally best to dispense with a separate bottle and adjust the size of the accumulator accordingly. This will provide a more economic solution.

With rapid cycling of the accumulator, isothermal conditions may not apply, when the adiabatic relationship should be used, viz—

$$V_f = V_g \left(\sqrt[n]{P_b/P_1} - 1\right)$$

For fully adiabatic operation the value of n is 1·4. However, this is unlikely to be realized in practice and more realistic figures are $n = 1.3$ for very rapid cycling, reducing to 1·1 for moderate rates of cycling, and according to the amount of heating realized.

Cutting-speeds During Machining

By A. G. AREND

IT is known that the total energy of machining does not increase in direct proportion to cutting-speed and that the quality of the surface obtained in machining metal is largely dependent upon the action of the cutting-edge, which is appreciably modified by cutting-speed under otherwise similar conditions.

At the lower cutting-speeds, the relatively considerable driving effort required may be explained by the increased surface roughness. It is important from the practical aspect that the surface finish should be as cleanly cut as possible, without showing shearing action on the surface-material, or jarring effects from tool-holder vibration. Surface roughness is largely dependent upon the amplitude of vibration of the cutting-tool, during shearing of the material in the swarf, and while magnifying-glass examination gives an indication of this roughness, a better criterion is acquired from photomicrographs. These have been used to illustrate the surface obtained in machining mild steel with a tensile strength of 28·57 ton per sq in. and containing 0·17% carbon. The cutting-tool speeds were 65·6, 164, 328, 492, 984 and 1968 fpm. The depth of cut was 0·0078 in. and the traverse of the tool was 0·0167 in. At speeds of 65·6 and 164 fpm the photomicrographs clearly indicated surface roughness which suggested a partial shearing action. At 328 fpm the surface was improved although still inclined to be rough, but for speeds of 492 fpm the prints presented a clean-cut surface. On the other hand, at speeds of 984 and 1968 fpm no further improvement was evident. Electrical apparatus was used for measuring the effort at the cutting edge of the tool and the vibration of the tool-holder was determined by oscillograph.

In a further experiment using a tungsten carbide cutting-tool with similar traverse and depth of cut, chrome-nickel steel with a tensile strength of 89 ton per sq in. was machined. Using a cutting speed of 65·6 fpm the pressure on the tool was 57·2 lb and vibration at the tool-holder was apparent. When the cutting-speed was increased to 656 fpm the pressure on the tool was reduced to 47·3 lb and the absence of vibration in the tool-holder was indicated as the oscillograph record formed virtually a straight line. The experiments demonstrated the benefits of small traverse and light cut, combined with high cutting-speed, ample power and rigidity of the tool and tool-holder.

Further experiments have been carried out to determine the most favourable conditions for cutting tools in drilling and turning steel, cast-iron and brass, wherein the time necessary to blunt the tool at a given cutting-speed was recorded. The cuttings were 0·04 in. thick and ranged from 0·079 to 0·31 in. width, while the cutting-angle of the tool was 68° and 68° 30′ respectively.

The angle of cut ranged from 30° to 90° with the longitudinal axis of the lathe. The power absorbed, and the pressure of the tool referred to the three rectangular axes, were measured for turning. The twisting moment was determined during drilling. The pressure in the direction of feed ranged from 88 to 198 lb while the vertical pressure ranged from 2420 to 1870 lb. Twisting moments were recorded while drilling a hole 1 in. deep and 0·2 in. dia with a point-angle of 118°. With spiral angles of 12°, 35° and 45° the twisting moments were 23·5, 4·3, and 8·7 lb/in. respectively, while the vertical pressure on the drill amounted to 242, 55, and again 55 lb. It was found that the tool, which had a cutting-angle of 64° 30′ was blunted in 60 min when turning steel with a Brinell hardness of 125. This was at a cutting-speed of 183·6 fpm, where the cuttings were 0·16 in. thick and 0·04 in. width. When using a cutting-angle of 68° and cutting-speed of 150·88 fpm, the speeds were 213 ft, and 187 fpm for the respective cutting-angles, for cuttings 0·08 in. thick and 0·04 in. width. The blunting time was found to be 1 hr with the cutting-angle at 68° when cutting steel of Brinell hardness 293. For cuttings 0·08 by 0·04 in. and 0·16 by 0·04 in. respectively, cutting-speeds of 49 and 39 fpm were recorded. Tungsten carbide cutters showed a cutting-speed of from three to seven times greater than for high-speed steel when engaged for similar tests.

Charts were made out for each material, referred to the diameter of the piece to be machined and indicating the cutting-speed, the pressure, and the power absorbed. The tests have been carried further by comparisons between lathes operated by fluid drive and ordinary gearing, while performing similar work. Standard cuts were compared in the two machines, using a special apparatus to measure the cutting pressure at the tool. With cutting-speeds of 1256 fpm the usual cut gave a cross-section of 0·0093 to 0·0108 sq. in. The two machines in general exhibited little difference, but the geared machine gave 9% better output with equal power consumption and at the same speed. It was concluded that while the lathe with fluid drive yielded only 10% higher output with 21% greater power consumption when working at full load, it actually afforded a saving of 7%.

The fluid drive at half load yielded 13% higher output with 31% greater power consumption, which represented a saving of 10% taking into account the cost of power and lathe-time.

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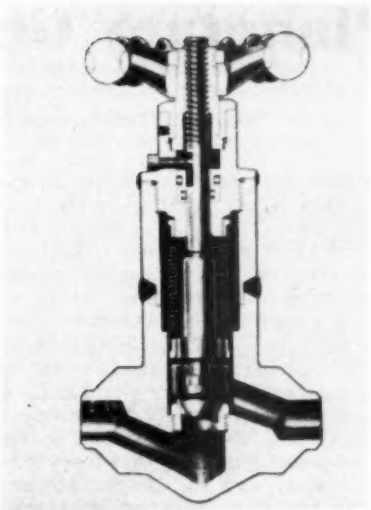
Bellows-sealed Valves

As a result of intensive development work on bellows-sealed valves for use on critical services, the Newman Hender Group of Woodchester, Glos., have, over the last three years, been able to reduce the cost of this type of valve by 50%. This means that valves with a positive nil leakage to atmosphere and, if necessary, guaranteed to have a working life of twenty or more years, can now economically be specified over a much wider field of application.

The valves are basically conventional in design but are machined to very close tolerances and are sealed



Section through a typical Newman Hender bellows-sealed valve showing how the bellows, welded top and bottom, provides positive sealing at the stem/bonnet joint giving nil leakage to atmosphere. Back seating is provided as a standard feature and additional glands or O-ring stem seals can also be fitted to give extra safeguards when required

to atmosphere by a specially designed stainless steel bellows instead of the normal gland packing arrangement. The bellows is welded to the bonnet at the top and to the stem at the bottom giving an absolute seal at the stem/bonnet joint.

As an example of performance, recent tests on several thousand Newman Hender bellows-sealed valves for nuclear service showed nil leakage to atmosphere using CO_2 at up to 450 psi. More significant, however, was the impressive seat sealing performance; the vast majority recorded zero seat leakage whilst the remainder were well within the rates specified in the contracts (e.g. 0·0026 lb/per day).

Newman Hender have produced a number of variations in the basic design to meet different requirements of service, pressure, temperature and problems of corrosion. The valve bodies can be in carbon steel or stainless steel with the valve trims also in stainless steel when required. Seatings may be the standard stainless steel or a deposited stellite seat integral with the valve body, or for control purposes, a needle type disc. For other special requirements ptfe seatings or a pintle disc and seat, incorporating protected faces, can be fitted. The standard valve incorporates back seating in the open position as an extra safety feature but additional glands or O-ring stem seal can be provided to give additional safeguards when required.

Prior to final seal welding the valves are hydraulically tested, using temporary seals where necessary, to the specified test pressures. After seal welding the integrity of the seal weld is finally checked by an approved gas test.

The standard pressure ranges are: $\frac{1}{4}$ in. and $\frac{3}{8}$ in. sizes, 350 psig; $\frac{1}{2}$ in. to 2 in. 450 psig. The standard temperature ranges are: carbon steel, −40°F to +800°F (−40°C to +427°C); stainless steel, −50°F to +900°F (−46°C to +482°C).

Five alternative standard valve-end connexions are available—screwed female (B.S.P. or A.P.I.), socket-weld, butt-weld, flanged or union, but special end connexions can be provided if required.

Planetary Gear Train Efficiencies

By D. H. OFFNER,
Associate Professor of Mechanical Engineering, University of Illinois

AN ordinary gear train in which all gears rotate about fixed centres is shown in Fig. 1. The system consists of gears a, b, c and d, and it is assumed that shaft 2 is the input member and rotates clockwise as viewed from the right with an angular velocity $\omega_a = \omega_2$ while transmitting a torque (also having a clockwise sense, since it is input). An analysis of the corresponding rotation of the other members shows that output shaft 4 also rotates clockwise at some angular velocity $\omega_d = \omega_4$ while overcoming a resisting torque $T_o = T_4$ which since it is at the output shaft, has an opposing sense (counter-clockwise). The input power is thus $P_i = + T_i \omega_a$ (the plus sign indicating that the sense of T_i and ω_a are the same) and the output power (resisting) $P_o = -T_o \omega_d$ (the minus sign indicating that the sense of T_o is opposite to the sense of ω_d). These observations suggest the "power" rule: *an input shaft is one in which the sense of its torque and angular velocity is the same; an output shaft is one in which the sense of its torque is opposite to the sense of its angular velocity.*

The following quantities are required for determining the overall efficiency of this gear drive:

e = overall efficiency of gear train
η_{ab} = efficiency for gear pair (a, b)
η_{cd} = efficiency for gear pair (c, d)
L = total power loss at gears of drive
$P_i = T_i \omega_a$ is input power
$P_o = T_o \omega_d$ is output power
$l = [1-\eta_i]$ P is power loss between a gear pair.
$m = \omega_a/\omega_d$ is the velocity ratio of the gear train.

The overall efficiency of this gear drive (excluding bearing losses) can be defined in terms of the input power and total losses as $e = (P_i - L)/P_i$. The total

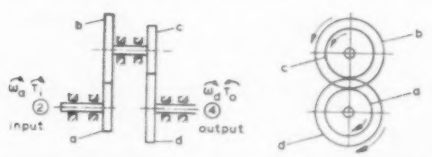


Fig. 1.—Schematic representation of ordinary gear train. Note that the sense of angular velocities and torques are given as viewed from the right-hand side

power loss in terms of input power consists of the losses occurring at each gear pair, namely

$$\begin{aligned} L &= l_{ab} + l_{cd} \\ &= P_i(1-\eta_{ab}) + \eta_{ab}P_i(1-\eta_{cd}) \\ &= P_i[1-\eta_{ab} + \eta_{ab} - \eta_{ab}\eta_{cd}] \\ &= P_i[1-\eta_{ab}\eta_{cd}] \end{aligned}$$

The overall efficiency thus becomes

$$e = P_i - P_i[1-\eta_{ab}\eta_{cd}]/P_i = \eta_{ab}\,\eta_{cd}$$

The overall efficiency could just as well have been defined in terms of output power. In this case

$$e = P_o/(P_o + L)$$

where

$$\begin{aligned} L &= l_{ab} + l_{cd} \\ &= (P_o/\eta_{cd})(1-\eta_{cd}) + (P_o/\eta_{cd}\eta_{ab})(1-\eta_{ab}) \\ &= (P_o/\eta_{cd}\eta_{ab})(\eta_{ab} - \eta_{ab}\,\eta_{cd} + 1 - \eta_{ab}) \\ &= (P_o/\eta_{cd}\eta_{ab})(1-\eta_{ab}\eta_{cd}) \end{aligned}$$

giving

$$e = \frac{P_o}{P_o + (P_o/\eta_{cd}\eta_{ab})(1-\eta_{ab}\eta_{cd})}$$

$$\begin{aligned} &= (\eta_{cd}\eta_{ab})/(\eta_{cd}\eta_{ab} + 1 - \eta_{ab}\eta_{cd}) \\ &= \eta_{cd}\,\eta_{ab} \end{aligned}$$

While it is true that in this ordinary gear train the overall efficiency could have been obtained more directly by considering only the power being transmitted at each pair instead of the power being lost, this method of using power losses in determining overall efficiency is the more logical approach in the case of planetary gear trains.

In Fig. 2 is shown schematically a representative planetary gear train. While it looks similar to the ordinary gear train of Fig. 1 it is quite different when analyzed kinematically. In this drive the designated input shaft 2 is integral with planet carrier arm A which supports shaft 3 to which are fixed gears b and c. Gear b rolls around fixed gear a while gear c rolls around gear d.

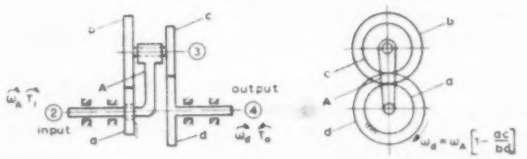


Fig. 2.—Schematic representation of a planetary gear train. Note that the sense of output rotation and torque is obtained from analysis indicated in Table I assuming ac/bd 1

Assuming that the sense of the angular velocity $\omega_A = \omega_2$ of the arm is clockwise when viewed from the right, and using the power rule, then the input torque will also have a clockwise sense. To determine the sense of the angular velocity $\omega_d = \omega_4$ and opposing torque T_o of the output shaft 4, the following analysis is used.

The relationship $\omega_d = \omega_A \longmapsto \omega_{dA}$, states that the angular velocity of gear d (and shaft 4) is equal to the vector sum of the angular velocity of arm A (same as shaft 2) and the angular velocity of d relative to A (i.e., the resulting motion obtained when imagining that arm A is fixed). The angular velocity of all the other members in this drive can be expressed in a similar manner. For example, the total angular velocity ω_a is equal to $\omega_A \longmapsto \omega_{aA}$, but since $\omega_a = O$ (fixed gear) then $\omega_{aA} = -\omega_A$. This means that the angular velocity of gear a relative to arm A has a sense opposite (counter-clockwise in this case) to the sense of ω_A.

Thus the angular velocity of any member can be visualized as consisting of the vector sum of two separate motions: the angular velocity of the reference member (planet arm A) and the angular velocity of the member relative to the reference member. The power available at any shaft can similarly be imagined as consisting of two parts. For example, the output power $P_o = T_o \omega_d = T_o[\omega_A \longmapsto \omega_{dA}] = T_o\omega_A + T_o\omega_{dA}$. The first term is not subject to gear mesh losses since it is that part of the total power which is transmitted when the entire system (including gear d) is imagined to be locked and turning with arm A. The second term (sometimes referred to as the circulating power) is subject to gear mesh losses and is thus the quantity to be considered when determining the total power losses and subsequent overall efficiency of the system. These particular features (a rotating planet

arm which provides an additional angular velocity component not present in ordinary gear trains and the resulting phenomenon that part of the total power is not 'circulating' within the system and is thus not subject to gear mesh losses) give the planetary gear train its special characteristics. They are indicated in Fig. 3. A convenient tabular method for analyzing and combining these separate motions is shown in Table I.

The first line (motion with arm) is obtained by imagining that the entire system is locked together with arm A (see Fig. 3) and thus every member rotates with an angular velocity equal to that of the arm (ω_A) (assumed with a clockwise sense for convenience). As indicated previously, transmitted power associated with this motion is not subject to gear mesh losses. The second line was obtained by imagining that arm A is fixed and that the other members rotate relative to the arm. Thus $\omega_{aA} = -\omega_A$ is the relative angular velocity of fixed gear a and the other relative angular velocities can be obtained by noting their subsequent motions in the system relative to the planet arm shown in Fig. 3. The letters a, b, c and d are used to represent the diameters

Table I.—SUMMARY OF KINEMATIC ANALYSIS

N	Type of Motion	Motion of Member in System: $A=2$	a	b, c	$d=4$	Remarks
1	Sub-system "locked" with Planet Arm, A	ω_A	ω_A	ω_A	ω_A	No gear-mesh loss
2	Sub-system relative to Planet Arm, A	0	$-\omega_A$	$\omega_A\, a/b$	$-\omega_A\, ac/bd$	Subject to losses
3	Total Motion	ω_A	0	$\omega_A[1+a/b]$	$\omega_A[1-ac/bd]$	Use to Determine Value and Sense of Angular Vel.
Note: use $+$ as sense of ω_A		Arm Input	Fixed Gear		Output	

of the gears. The transmitted power associated with the relative motions are subject to gear mesh losses. The total motion (third line in the table) is the algebraic sum of the other two motions and provides a means for determining the velocity ratio of a planetary gear train

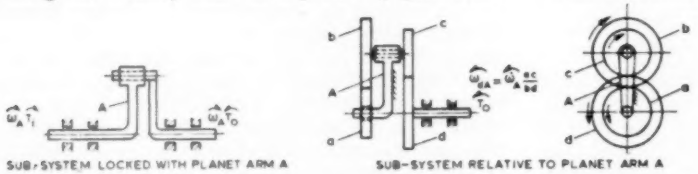


Fig. 3.—Kinematically equivalent sub-systems

and output shafts. For example, the velocity ratio of this planetary gear drive is

$$\omega_A/\omega_d = \frac{+\omega_A}{+\omega_A[1-ac/bd]} = +\frac{1}{1-ac/bd} = m.$$

If we assume $ac/bd < 1$, then both ω_A and ω_d are positive (i.e., they have the clockwise sense assumed for arm A).

To determine the overall efficiency of this system, we know that all power losses are associated with the power transmitted in the sub-system relative to the planet arm (Fig. 3). It has already been noted above that if $ac/bd < 1$ the sense of the angular velocity of the output shaft is clockwise (the same as arm A). The power rule tells us that the sense of the output torque T_o should be opposite to this, or counter-clockwise. This sense is indicated in Figs. 2 and 3. But line 2 of Table I tells us that the sense of the relative angular velocity of the output shaft $\omega_{dA} = -\omega_A(ac/bd)$ is also counter-clockwise. Again applying the power rule to the system relative to the planet arm, as well as determining the sense of rotation for input we see that the "circulating" power $T_o\,\omega_A(ac/bd)$ available at shaft 4 must be considered as input when determining the total power losses of the system.

Using the same definitions and method that were used in determining the total power losses in the ordinary gear train, we can now proceed as follows:

$$e = P_o/(P_o + L)$$

where $P_o = T_o\,\omega_d = T_o\,\omega_A[1-(ac/bd)]$

and $L = l_{ac} + l_{ab}$ (losses in relative sub-system)

$$= T_o\,\omega_A(ac/bd)[1-\tau_{ac}] + \tau_{ac}\,T_o\,\omega_A(ac/bd)[1-\tau_{ab}]$$

$$= T_o\,\omega_A\,(ac/bd)\,[1-\tau_{ac}\,\tau_{ab}]$$

giving

$$e = \frac{T_o\,\omega_A\,[1-ac/bd]}{T_o\,\omega_A[1-ac/bd]+T_o\omega_A\,ac/bd[1-\tau_{ab}\tau_{cd}]}$$

$$= \frac{1}{1+[(ac/bd)/(1-ac/bd)]\times[1-\tau_{ab}\,\tau_{cd}]}$$

$$= \frac{1}{1+(m-1)[1-\tau_{ab}\,\tau_{cd}]}$$

The overall efficiency depends upon the relative sizes of the gears (a, b, c and d) as well as upon the efficiency of each gear pair. By introducing the velocity ratio as defined earlier, the overall efficiency can also be obtained in terms of the velocity ratio as indicated.

It is also interesting to observe that the ratio $(ac/bd)/(1-ac/bd)$ represents that fraction of the total available output power that is "circulating" within the system and thus subject to gear mesh losses.

The various steps used in finding the overall efficiency are summarized in the Appendix. The method is sufficiently general for it to be used for any planetary gear drive including those having more than one input or output shaft as well as those used in conjunction with ordinary gear trains. The method can also be used to determine the power (and/or torque and forces) on any shaft or gear in the system and thus may be used in checking design criteria for the various components.

This discussion on planetary gear train efficiencies was adapted directly from a machine design lecture given by the author to engineering students at the University of Illinois and was based in part on material from the references below.

Appendix.—Summary of Procedure

1. Represent schematically two views of the given gear drive.
2. Represent schematically the two sub-systems that are kinematically equivalent to the given gear drive.
3. Obtain the relative and total angular velocities (magnitude and sense) of the input and output shafts, using the tabular method suggested. Indicate these quantities and sense of the corresponding torques in the schematic representations of the gear drive. Use the power rule.
4. Determine the total power losses in the sub-system relative to the planet arm. Treat the shaft *not* integral with the planet arm as the input or output shaft (indicated by the power rule) of this sub-system.
5. Determine the overall efficiency in terms of the total power losses and total input or output power. Use the total power associated with the shaft *not* integral with the planet arm. Always use the absolute magnitude of calculated power losses.

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Some Recent Developments in Belt Conveyor Practice

The installation and upkeep of belt conveyors in many industries represents a considerable proportion of the cost of manufacture of the product. The belt itself may well cost over half the total price of the conveyor system, whilst interruptions due to breakdown or repair will have serious effects on revenue. The present article deals with some of the improvements which have been introduced in recent years particularly those concerned with increasing the life of the belt

By A. R. MYHILL, M.I.Gas E., M.Inst.F., F.R.I.C.

The conveyor belt.[4,5,6]

THE belt is the most vulnerable component of a belt conveyor and with the increasing use of conveyors of this type for moving heavy loads of material, often of an abrasive nature, and sometimes at relatively high temperatures (e.g. for coke), it is becoming more and more necessary to employ specially strong, flexible and mechanically resistant belt material. Some of the principal factors upon which belt life depends, include:

(1) Composition of the materials of construction of the belt.
(2) Design of the belt in regard to the disposition of the various materials used in its construction.
(3) Mechanical wear and tear relating to:
  (a) Physical properties of the load.
  (b) Temperature variations, chemical and physical nature of atmosphere and other ambient conditions.
  (c) Faults in alignment or training of belt.
  (d) Slip and creep of the belt due to rotation of driving drums.
  (e) Faulty belt fasteners.
  (f) Punching, tearing and edge damage due to trapping of conveyed material between driving pulleys, idlers, etc. and belt.

Construction of the belt

Conveyor belts are designed to work with either a flat horizontal surface or with a troughed formation. The former is usually employed for the transport of comparatively heavy articles of standardized dimensions, which remain on the belt during transit, without any movement relative to the latter. Troughed belts usually work at higher velocities and are used for carrying material in various states of division from large lumps to powder, either uniformly or heterogeneously sized, and small, but significant, movements of material can take place along or across the belt in the course of transport.

The present article is concerned mainly with this latter type. The belt must be so designed as to be flexible in order to bend round the driving and return pulleys and snub pulleys; to be capable of troughing if necessary, and sufficiently strong to take the pull of the conveyor, and possess the requisite degree of resistance to abrasion and other destructive influences.

There are two basic belt components, (a) the plies, constructed of woven material, giving strength to the belt, (b) the covering or facing. This is a natural or synthetic rubber product, known, when cured, as "friction" or "adhesion", which serves to hold the plies together, and protects the fabric of the plies from corrosion and abrasion. Cotton duck plies or carcase protected by a natural rubber covering was universal in the early part of the present century, and this combination still holds an important place, although the advent of synthetic materials which can be prepared as required to close specifications has largely resulted in displacing the natural products. The use of rayon, nylon and terylene has enabled stronger and more flexible belts to be made, while special synthetic rubbers are now used which are superior to the natural product under high temperatures or oily conditions.

The belt carcase

Despite the factors of superiority of synthetic fibres, it is not always practicable to make full use of their greater flexibility and their light weight, and in many cases the bulk and firmness of a cotton belt may be of greater value than flexibility, as in the case of short, wide belts where the plies are needed to support the load rather than to withstand the tension. It is often the practice, therefore, to combine different types of fibre, using either mixtures of synthetic materials or in combination with cotton.

The characteristics of a textile yarn depend on the nature of the fibres or filaments, and the properties of the cloth relate to the system of weaving. Continuous filament yarns made from synthetic products are produced by extrusion of the material, while staple spun yarns such as cotton are made by spinning of short fibres, of length $\frac{1}{2}$ in. to 2 in. The fibre length in the case of cotton is an important factor in the strength of the belt. The duck consists of warp threads running longitudinally through the fabric, and weft threads across the width of the belt. The warp threads are generally much stronger than the weft, being larger in cross section and in closer proximity than the latter.

Ducks are specified and bought according to the ounce grade, but each manufacturer has his own particular construction, and cloths of the same weight grade may vary in number of spun yarns from which it is constructed, number of yarns per thread, number of threads per in., tightness of twist, etc. and the warp construction may differ from the weft.

Of the synthetic fibres, rayon is a satisfactory warp member, and it offers a high impact resistance, although its strength/weight ratio is lower than that of nylon or terylene. Its main disadvantage is its loss of strength when wet, which may, with some types, be as as high as 40% when saturated with water. Considerable improvements have, however, recently been made in both wet and dry strengths of rayon, and rayon—warp/nylon weft fabrics are now widely used.

Nylon has the highest strength/weight ratio of the

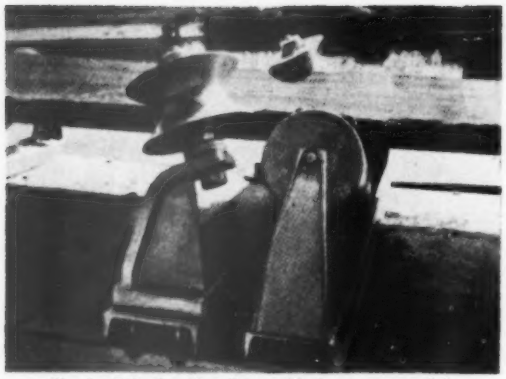


Fig. 1.—Pair of guide rollers positioning a conveyor belt

Fig. 2.—Suspended idler belt conveyor

synthetic fibres but is more extensible than rayon or terylene, and is finding considerable demand in cotton-nylon belts as the weft. In such belts it is often necessary to bulk-up the weft with cotton in lightweight belts, but with heavier belts there is generally sufficient nylon alone to produce a good fabric design.

The principal development of terylene for making belts is a terylene warp and a cotton weft. This has replaced all-cotton in some installations with a smaller number of plies. Tereylene is remarkably resistant to acid and alkaline corrosion, and its resistance to heat is exceptionally good, it being capable of withstanding temperatures up to 200° C for comparatively long periods without undue loss of strength.

The number of plies in the belt is very important since this effects strength, flexibility over the pulleys and idlers, and the amount and effects of troughing. The belt should be of such a weight that it will conform to the idlers when troughing. Too many plies makes a belt too rigid and may cause riding on inclined rollers, introducing alignment difficulties and excessive edge-wear. Too few plies may result in excessive stretching. If the belt is too rigid over a small diameter driving drum, surface contact may be insufficient and slip will occur, resulting in high power consumption and excessive wear.

The rubber belt covering

The life of a belt may be taken as being approximately proportional to the wear-resisting properties of the rubber covering, assuming, of course, that the tensile strength of the carcase is satisfactory. The covering should be selected for its ability to resist abrasion. The cover thickness required will depend upon the material

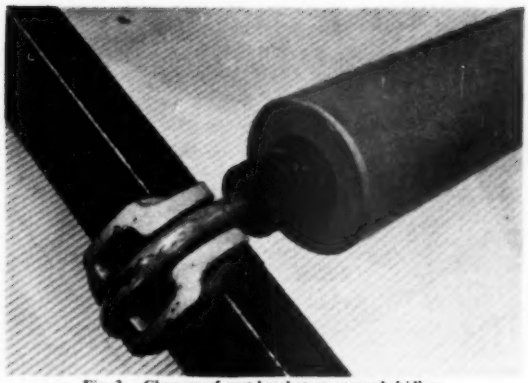


Fig. 3.—Close-up of cast bracket on suspended idlers

being handled and the speed of the belt. Typical thicknesses may range from $\frac{1}{16}$ in. to $\frac{3}{8}$ in., and will increase in amount as the size of material becomes larger.

There are several kinds of synthetic rubber and they all possess the advantages, over the material product, of closeness to specification and, in general, stability of price. For use in belt manufacture the following types are now used:

Butyl rubber (isobutylene-isoprene) sometimes known as IIR has the properity of resisting temperatures up to 175° C without hardening or cracking. It is relatively impermeable to air, and this property, (which, of course, is an outstanding advantage in the construction of tyres) necessitates special precautions to avoid trapping air pockets during the processing of a belt.

Special rubbers, relatively high in cost are used to a limited extent for protection at high temperatures. Of these, neoprene, a polychloroprene polymer (CR) is notable for heat resistance even in the presence of flame, and is highly resistant to oil.

Silicone rubber, although exeptionally resistant to heat (over 205° C) is rarely used for belting on account of its high cost and low resistance to oils and hydro-carbons.

Styrene-butadiene rubber (SB), also known as cold rubber, from its method of production, has a lower tensile strength than natural rubber, but a higher resistance to abrasion and will withstand temperatures up to 125° C. Many authorities consider it the best cover for carrying quenched coke at gas works and coke oven plants, where there is always an element of danger of red-heat if a large piece of incompletely quenched coke breaks on the belt and exposes a glowing centre. In some cases, this danger is avoided to some extent by the use of a layer of asbestos fabric beneath the rubber cover to protect the rayon or terylene carcase.

For making certain special fuel products, coal is conveyed along a belt in admixture with oil, and the oil can cause bad swelling of natural rubber belts. In such cases, neoprene belts are recommended.

Puncturing, longitudinal tearing and edge damage can be caused by material trapped between the belt and pulleys. A serious source of damage is scrap iron travelling on the belt. This often causes longitudinal splitting, and one method of localizing the damage is to build wire strands (rib stops) into the belt to deflect the tear to the edge of the belt.

Improvements relating to the driving and running of the belt[3,4]

Although a properly designed and well built belt conveyor installation will give excellent service over a

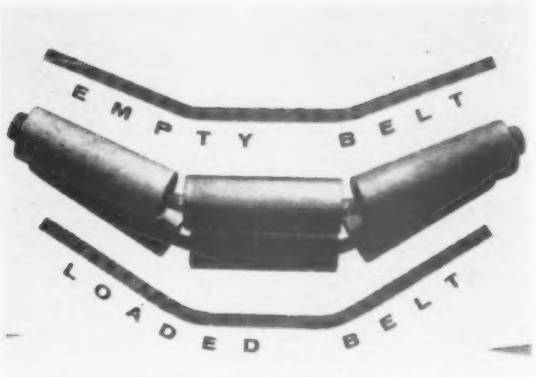


Fig. 4.—Positions with empty and loaded belt of suspended idlers

Fig. 5.—Conveyed material being discharged from suspended idler conveyor

long period, circumstances often arise when adverse conditions may develop which are inherent in the use of the system. In some cases the alignment of heavy-duty plant may not always be permanently stable. Excessive loading of belts or uneven distribution of load may cause spillage on to pulleys, shafts, and bearings, and bad adjustment can wear away belt edges.

On this account it is common practice to use straight sided upright guide rollers. Such rollers can, however, contribute to belt damage since the belt may wear a groove in the roller and become confined in this groove, causing irreparable damage by bending and wearing away the belt edge.

Special guide rollers are now in use which incorporate mechanical principles to avoid this trouble by increasing the control area between the belt edge and the guide and so reduce the pressure per unit area of contact. These employ a hyperbola in the design, which, when tilted at the proper angle (30°) to the plane of the belt edge, offers a revolving, long-line contact surface which guides the belt with minimum damage.[2]

Fig. 1 shows a pair of these guide rollers positioning a conveyor belt.

Because of lack of rigidity there is always a tendency for a belt to oscillate between the carrying idlers, such oscillation being related directly to load and speed. The improved guide roller mechanism therefore incorporates an axial movement with its revolving motion, thus allowing it to follow the normal lift motion of the belt, while continuing to exercize protection of the belt edge.

With a troughed belt conveyor, the troughing angle of the carrying idlers must be sufficiently shallow for the empty belt to trough down into contact with the centre roll for effective belt training. On the other hand, for maximum carrying capacity and elimination of spillage, the troughing angle should be as deep as possible. These two opposed requirements have led to a compromize being accepted in the case of the fixed troughing angle or curve type conventionally used. The meco suspended idler structure, designed and constructed by The Mining Engineering Company Limited, Worcester, fulfils both requirements.[1] The idlers comprise three rolls, flexibly coupled together by chain links. Housed entirely within the side rolls are heavy spring assemblies coupled to hooked bars upon which the idlers are mechanically suspended, (Figs. 2-5) the sliding coupling being protected by a bellows seal.

When the idlers are hooked over the rectangular hollow stringers, they trough against the spring loading in relation to the weight of material on the belt, up to the limit imposed by the restriction of the spring yield.

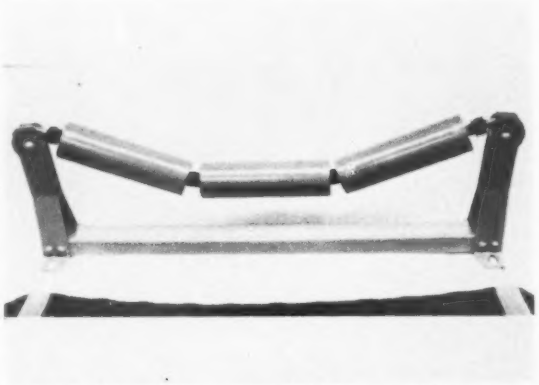


Fig. 6.—Cradle mounting of suspended idlers on an existing conveyor

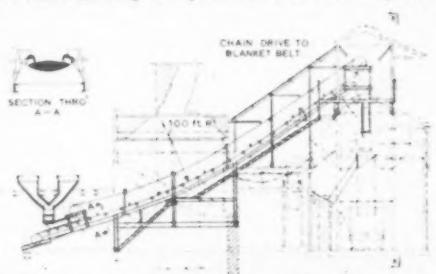


Fig. 7.—Blanket conveyor at Bow Common Gas Works for handling coke (North Thames Gas Board)

The troughing angle for the unloaded belt is approximately 20°, which allows even the stiffest belting to make full contact with the middle roll for effective belt training. The troughing angle then increases progressively with loads up to a limit of approximately 32° with a fully loaded belt, to give the maximum carrying capacity, freedom from undulation and minimum spillage. The freely suspended linked idlers take the form of the loaded belt, yet remain resilient to avoid damage from blocky material. The smooth running of the belt also reduces the dissemination of dust through the belt joints. Cradle mountings (Fig. 6) are used on existing conveyors or for other special purposes in order to make available the advantages of these resilient suspended idlers.

The blanket conveyor[3]

A development in belt conveyor practice was described in 1955 by F. R. Waple, Engineer Designer of the Chief

Engineer's Department of the North Thames Gas Board. This related to a method of extending the usefulness of the conventional belt conveyor by making it possible to increase substantially the angle of incline up which loose granular material may be raised, and thus obtain the advantages of belt transportation in cases where space requirements would otherwise preclude it.

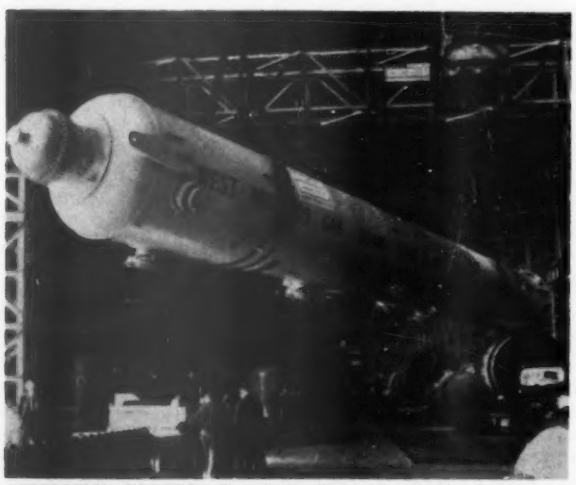
The device has since become well known under the term "blanket conveyor". The patent is held by The North Thames Gas Board in conjunction with the designer and manufacturing rights have been granted to W. J. Jenkins & Co. Limited, International Combustion Products Limited, Birtley Engineering Limited, and Robert Cort and Son Limited.

Material travelling up an incline on a conventional belt conveyor would start to run backwards down the slope when the angle exceeded the recognized angle of repose. In the case of graded coke, for instance, this angle would be about 28°, although in practice a maximum of 18° would be considered to be the limit on account of the jolting action of the supporting idlers.

The blanket conveyor is designed to overcome this drawback by using a subsidiary belt which rests on the material on the carrying belt, and has the effect of blanketing the downward flow and making it possible to increase greatly the angle of incline. In connection with the increase in angle, it is generally assumed that this will be of the order of twice that normal for the angle of a standard conveyor. This should only be considered as a guide because in the case of coke it can be rather more than twice (say 38°) whereas in the case of ice the blanket could not achieve twice the angle.

Fig. 7 shows the original blanket conveyor at the Bow Common works of The North Thames Gas Board in 1955. Coke is fed on the carrying belt at the bottom where the inclination is 18°. The belt then rises on a curve, the maximum inclination at the top being 35°. The material is discharged over the head pulley of the carrying belt in the normal way but the blanket extends about 3 ft to its own head pully, thus enclosing the coke between the two belts until it is discharged into the chute. The head pulleys of both belts are of equal diameter (say 24 in.) the carrying belt being driven by a direct-coupled worm gear or geared motor. At the other side of the head shaft there is an equal ratio chain drive to a counter-shaft and thence an equal ratio spur gear to to the blanket belt head pulley, thus ensuring similar speed and direction of both belts. The carrying belt is supported on troughing idlers, and adjustable guide pulleys are arranged to operate as sealing rollers on the top of the blanket belt.

The material carried thus occupies the whole of the space between the bottom face of the blanket belt and the top face of the conveying belt without spillage. This is shown in the enlarged section A.A. in Fig. 7.



ABSORPTION TOWERS.—One of two 65-ton CO_2 absorbers made at the Greenwich Works of G. A. Harvey & Company (London) Limited, to the design and order of Woodall-Duckham Construction Company Limited, for the new West Midlands Gas Board Lurgi Plant at Coleshill. Each tower is 85 ft long, 8 ft 6 in. dia and was hydraulically tested by Harveys to 575 psi

Acknowledgments

The writer wishes to acknowledge with thanks the co-operation and help given by the makers and users of belt conveyor equipment who have supplied information and illustrations, in particular the Chief Engineer's Department of the North Thames Gas Board and the Mining Engineering Company Limited (Worcester).

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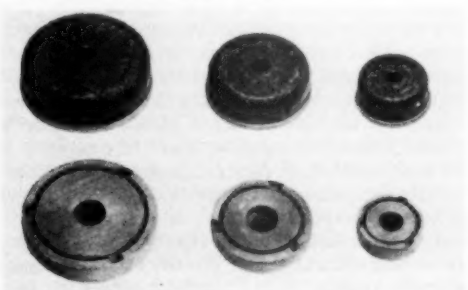
Glass Fibre Roving Pack

A 75% reduction in the amount of package handling and also a cut in the downtime on glass fibre depositors, can be effected by a new "Multipak" container introduced by Turner Brothers Asbestos Company Limited, Rochdale, for holding their "Duraglas" glass fibre continuous roving. Each Multipak contains four cheeses of roving, the end of each cheese being fastened to the beginning of the following one to give continuous unwinding throughout the carton. This method of packing obviates the necessity of stopping the depositor at the end of each cheese, and minimises the amount of re-threading, which are time consuming operations when using single packed cheeses. 'A' glass or 'E' glass roving can be supplied in the new Multipaks, but the single cheese cartons will be retained in the range.

Shallow Pot Magnets

For use in more confined spaces a modified design of Eclipse pot magnets is now available giving smaller back-to-front dimensions thus extending the innumerable lifting and holding applications of this type by reason of its flatter design. These shallow pot magnets are in effect flat Alcomax magnets assembled in mild steel shells, the magnets being cored with a countersunk hole for securing by a screw or bolt. Three sizes are available $1\frac{1}{2}$ in. dia $\times \frac{7}{16}$ in. high, $1\frac{1}{8}$ in. dia $\times \frac{3}{8}$ in. high and $\frac{3}{4}$ in. dia $\times \frac{5}{16}$ in. high. Makers are James Neill and Company (Sheffield) Limited, Sheffield 11.



Eclipse shallow pot magnets

Metal Sawing—II

Conclusion of a survey of different kinds of saws and sawing machines in relation to the materials and conditions encountered over a wide industrial range of application

THE friction saw has continued to be employed in foundries but has been considerably improved. It is not strictly a saw at all, but a notched circular steel blade which, running at about 25,000 to 30,000 ft/min generates so much heat at the point of contact with the work that it burns rather than saws its way through the work. These discs are so often termed saws, however, and are so similar in application to circular saws, that they may be called saws, all the more since the machines in which they are used are made by the same firms that make sawing machines proper.

Many thousands of these discs are made in various sizes and gauges from a special steel. They are particularly effective for taking a quick and rough cut. One great advantage of these discs is that it is not necessary to change the blade to cut different sections. Cracks readily develop at the teeth owing to the intense heat, so prompt attention must be paid to these. A common cause of cracking and bad cutting is the spraying of water on the hot blade (a trouble often met with hot saws also). This should be done with moderation because excess of water keeps air away from the point of contact between metal and disc. The oxygen necessary for burning is then excluded and the hot rim cracks.

The disc cutting edge should be regularly turned or ground true, and the disc should be taken out of service when this edge has become burred over with metal. The notches cut in the rim must be kept sharp and uniform. Failure to keep the notches sharp means that the saw does not develop sufficient heat and has therefore to force its way through cold or only warm metal. The cutting edge must be kept clean and true to maintain correct saw tension. If the disc, when running, seems out of truth, it should be removed at once and sent back to the maker to be rehammered.

The metal-cutting bandsaw is used for cutting cold steel and particularly the heads and runners from steel and other castings, as well as brass, copper, aluminium and other non-ferrous metals, and cast iron, etc. These bandsaws are usually made in widths from ½ to 3 in. in a variety of gauges and can be had in long coils or cut to length. They should run at about 100 ft/min. For sawing cold mild steel, the feed should be 4 in./min up to 3 in. square, 3 in. up to 6 in. square, 2 in. up to 9 in. square, and 1½ in. up to 12 in. square.

Band saws are sometimes hardened on the teeth only, the main width being left soft, or they may be chilled, on the teeth, especially when cold cast iron or steel is sawn. Saws with hardened teeth usually have flexible backs, and 6 to 20 teeth/in. Chilled tooth saws have 4 teeth/in. Operating conditions are too variable to give speeds and number of teeth/in. for specific materials—in general, the greater the number of teeth, the lower the speed, and vice versa.

Saws must be kept sharp and a bandsaw should never be run with blunt teeth. Faulty setting leading to inadequate clearance is another common cause of failure. Excessive set is also harmful and leads to fracture. These troubles can often be detected. For example, inadequate set causes lumps on the saw to look bright and clean, while the hollows look dull. This shows the saw needs to be rehammered. If the saw cuts out of straight and the back catches in the cut, the setting is obviously irregular.

Uneven or excessive tension causes fracture and faulty running. Sharp corners in the tooth gullets cause cracks. Gullets should be well rounded. Dulled teeth, erratic cutting and possibly a defective wheel face may force the saw too forcibly against the guides, especially the back roller. This work-hardens the saw back which becomes too hard and cracks. Similar trouble may be experienced if the guides bear too much on the saw. Never try to go round sharp corners with band saws which are too wide for the work, or take deep and heavy cuts with too narrow a saw.

While wheel slip must be prevented, incorrect tension when fitting the saw in the machine may cause trouble. Humps and hollows in the blade, too high a cutting speed, case-hardening of the gullets by heat generated in grinding, faulty bearings, bad alignment of saw pulleys, hump in the tooth gullets, gumming of the wheel face, defective wheel covering, cuts on the surface of the saw, structural changes in the steel caused by excessive hammering in manufacture, vibration of machine or band, inadequate gullet giving insufficient clearance, and excessive crowning of the back of the blade, are all potential causes of failure.

There is a specific speed for each operation, arrived at by experience, and if this is exceeded, rubbing will set in and the teeth will wear at an excessive rate. Feed should never be too heavy and continuous operation is not recommended. Seven hours uninterrupted cutting is as much as the saws should be required to do before being re-set and sharpened.

When sawing such light metals as duralumin, about 1 in. thick, the most suitable speed is about 1000 ft/min peripheral speed, but this is merely a general guide and should be varied to suit the conditions.

It is advisable for the operator to know the theory of restoring the bandsaw tension, that is, making the metal in the centre of the saw spread or flow under the impact of the hammer towards the saw edges. It is difficult and skilled work but most important. Tension must be adapted to the pulley face and the wheel speed. So many kinds of work are now expected from bandsaws that it is always better to put special problems to the saw maker, who has even greater experience of saw cutting than the maker of the machines.

Cutting-off feeding heads in foundries is mostly done on the vertical bandsawing machine, but not every large casting can be dealt with in this way. For this reason the horizontal radial band saw has been developed. The work tables of these machines can usually be rotated in the desired direction. Thus, if it is necessary to saw off the boss of a large wheel, the wheel will revolve while the sawing is going on. This means that

the saw will need to cover only the distance from exterior of the boss to core, thus saving much time.

In some machines of the horizontal type, the arm carrying the pulleys and blade can be pivoted out of the way so that the work can be readily lifted by overhead crane. A wheel that can be tilted gives proper saw-tracking, the angle of tilt governing the extent to which the saw climbs or rides up the pulley face.

Saw tensions should always be relaxed when the machine is left idle for more than a few hours, e.g. overnight or during shut-down or when there is no work for it to do. This is because the stresses in the saw after cutting are not uniform over the entire length and where the idle saw runs over the wheels the stress is greater than in the straight parts. When cutting ceases, the saw cools and stresses caused by contraction are set up.

The saw should always be of the right length for the machine. Straightness is often lost after a sufficient amount of cutting and then the blade should be examined on a levelling table and all humps, bends, twists, etc., should be carefully hammered out. The saw back should have any irregularities corrected by hammering. These operations are best done by the saw maker. Bandsaws toothed on both edges can be had and cost rather more than the normal type.

Hacksawing machines are less used for removing runners and feeding heads than bandsaws, but they are very useful for general cutting. Skill is necessary in using them, to prevent breakages. The blade must be firmly secured in its frame, properly tensioned, and prevented from twisting as it cuts. Usually the teeth are given a rake or slope so that they cannot cut in both forward and backward directions. The pressure must therefore be applied to the blade only during cutting, and the blade should be lifted clear for the return stroke. Four positions of the blade are provided by the saw frame. The whole length of the blade should as far as possible be used for cutting. If cutting is concentrated on a few inches in the centre, the teeth will wear unevenly and the blade will have to be scrapped before more than half its normal service life has been obtained.

Minimum cutting pressure with a new hacksaw blade is essential on hard metals to prevent the teeth being torn out. Cast iron, brass and gunmetal are best sawn without lubricant. Mild steel needs a small amount of grease. If the blade sticks in the cut or chokes, it should be taken out of the cut and the chips cleared. A high rate of speed with lubrication appears to be best as the lubricant cools the blade, helps it to penetrate the metal faster, and keeps a keener cutting edge. Too light a pressure may cause the teeth to slip over the work, run in the cut, reduce cutting speed and increase tooth wear. Too heavy a pressure wears the teeth rapidly, renders the blade untrue, and eventually causes fracture and spoiled work.

We mentioned earlier that notable advances in sawing have been made during the last fifteen years. The circular saw has largely replaced the bandsawing machine on mass production because of its higher cutting speed, but the bandsaw still has its uses and is often the most economical and satisfactory way of dealing with work of large diameter and irregular form.

High velocity sawing is a development of friction sawing. In this, speeds of up to 22,000 ft/min have been achieved. The quick form-cutting of exceptionally hard and sometimes unmachinable metals is possible, among the materials cut being steels and steel alloys, stainless steels, armourplate steels and tool steels, much higher rates of output being obtained than with other saws.

These saws are particularly useful for cutting heat-sensitive materials such as Hastelloy, because the heat rarely penetrates more than 0·002 in. Sometimes, however, as with carbon steels, it may go to 0·005 in. The sawing is carried out on metal in thicknesses of about $\frac{1}{2}$ in. cross-section, but armourplate steels have been successfully cut up to 2 in. thick as a commercial job. The accuracy of the saws is such that some jobs have been sawn within 0·005 in. of the required form. A burr is developed as a rule and remains on the underside of certain pieces.

The main advantages of these machines are the extremely rapid cut and economy of handling, because no clamping is required. The special blade is exceptionally robust, and it is claimed that it will last for thousands of cuts. It can also be resharpened several times at low cost. There is no danger to the operator, as with abrasive discs, and no expensive resharpening if a tooth breaks, as when the normal high speed steel saw is used. Examples of the cutting times are $\frac{3}{4}$ sec for solid mild steel bar 1 in. by $1\frac{1}{2}$ in., 5 sec for channel 6 in. by $1\frac{1}{4}$ in., $2\frac{1}{2}$ sec for mild steel bar 3 in. by $\frac{5}{8}$ in., 3 sec for $4\frac{1}{2}$ in. tubing.

The high speed steel cutting disc is 21 in. dia. Any steel that can be cut at all, and many other materials, can all be sawn. In one model the cutting unit can be elevated to allow choice of the most suitable cutting angle. No dust or smoke is created. The discs are 1·8 and 3 mm thick, Cuts up to 12 in. long and 6 in. wide can be made.

Another recent development is sawing with segmental saws on a vertical cold sawing machine, the work being held central to the line of action of the saw and always at the same table level, which makes it easy to use roller conveyors. The machine will take blades from 26 to 30 in. dia. A 30 in. blade will saw sections up to $10\frac{3}{4}$ in. dia or $9\frac{3}{4}$ in. square. Angle cuts up to 45° can be sawn on sections up to 15 in. by 6 in. with the web horizontal. Four cutting speeds are available: 30, 45, 60 and 80 peripheral ft per min. Feeds up to 25 in./min can be chosen during the cut.

A valuable advance is the horizontal type of bandsawing machine in which the bands are helically wound on a drum, and which rewind automatically after cutting. They are exceptionally accurate and give delicate contours.

Then there is the double-cutting bandsaw for iron and steel in the cold state, and particularly for sawing off test pieces, cutting medium-sized castings and general sawing, wherever two pieces can be sawn at one and the same time with a single saw band. It is said that this machine will do from 50% to 75% more work than any other of its type. One piece is sawn by the downward-running side of the band and the other by the upward-running side. There are two self-acting work tables operating independently of each other so that proper feed may be given to each for work of different depth. The saw speed is constant, but the feed rate variable.

A new pattern of tooth having a flat top has been developed as a result of extensive research and experiment, and is particularly designed for hot sawing, but perhaps the most outstanding results have been achieved by a new swage saw. This has the cutting edge swaged out to make it about $\frac{1}{16}$ in. wider on the cutting face than the general thickness of the circular saw blank. The tooth size has also been reduced, and one user has reduced the pitch of tooth to $\frac{1}{4}$ in. This saw is achieving

revolutionary results in hot mill cutting inasmuch as no flash is left on the stock being cut. The horsepower of the motor is considerably reduced, and at one mill the ammeter when cutting 36 in. by 12 in. universal beam sections has been reduced from 200 to 50 amp. The saw also has a much longer life between changes in the mill, which cuts down time, eliminates deflashing costs in the warehouse, and saw-changing time.

Tungsten carbide circular saws of 50 in. dia have been introduced for cutting aluminium plate up to 57 ft long, 10 ft wide and 6 in. thick, and are in successful operation. They will run at 13,500 ft/min. Smaller cemented carbide saws have already been found suitable for cutting non-ferrous metals.

Friction sawing has been applied to bandsaws, which have been designed to run at surface speeds of 20,000 ft/min and over. These burn their way through steel by melting it with the frictional heat generated. In a sense they are more like an oxygen burner than a saw.

It remains now to give a brief indication of the desirable procedure for a few particular metals. Aluminium requires circular saws having chip-breaker teeth, with teeth so profiled that one cuts deep and the next cuts wide. Alternatively, the saw may have alternate side-rake teeth of about 15° rake. The top rake may vary up to about 45°. Large rake angle is better than small because fewer resharpenings are required. Negative rake should never be used. Proper clearances are essential to prevent dragging in the saw cut and consequent overheating. Comparatively coarse teeth with curved gullets and without sharp corners or burred edges should be used.

Bandsaws for aluminium should be of high speed metal-cutting type, though heavy duty bandsaws for wood can be used for light work. Cutting speeds range from 2000 to 5000 rpm, but higher speeds may be used if proved satisfactory. Spring-tempered steel bands are suitable for light work, but heavy work demands a flexible back blade with hard teeth, about eight to the inch, unless conditions demand a finer tooth. Fine feeds, relatively speaking, are used to prevent large chips, but feed is governed by the form, dimensions and character of the work. A coolant is advisable for heavy work.

Saws for cutting copper alloys can run at high speeds, particularly on leaded brass. Thinner high speed saws or blades can be used on copper alloys than on other materials owing to the lower temperature generated by cutting. Coarse tooth saws with no hook are best for leaded alloys but as the copper content increases, so should the hook. No coolant is needed for sawing leaded brass. Carbide-tipped blades can be used with effect in automatic sawing machines. Speeds range from 750 to 6000 ft/min according to the form and size of the work.

Magnesium can be readily cut by either band or circular saws. The bandsaws should have six teeth to the inch for light work and four to the inch for heavy work, blade widths being 1⅜ to 1 in. for light and 1½ to 2½ in. for heavy work. Tooth set should be greater than standard to minimize friction. Circular saw blades should be about 10 in. dia by 0·04 in. thick, with from 3 to 7 teeth/in. and a set about 0·055 in. for cutting sections about 2 in. dia. Hacksaws need teeth about 14 to 18 to the inch. every third tooth being a clearance tooth without set. Power hacksaws should be from 2 to 10 teeth/in. according to the work.

Stainless steels of the 18-8 austenitic type are always difficult to saw and in any event no great speed can be achieved. Straight chromium steel alloys can be slotted at the same speed as for ordinary steels, and no difficulty should be experienced if high speed steel saws are used with fine teeth of ample rake, and as long as the saw is not allowed to ride on the surface of the metal. Slotting speeds must be reduced by about 50% for 18-8 austenitic stainless steels. It is often an advantage, where this can be done without detriment to the work, to use a free machining type of stainless steel for shaving, slotting and drilling.

Bandsawing and cutting with abrasive discs are in reality two quite separate and distinct jobs. An abrasive disc is normally employed for the cutting of bars, whereas the bandsaw in the foundry is used for the sawing of the risers and runners of castings of irregular shape. It is, therefore, hardly possible to compare them. The modern bandsawing machines are so versatile and adaptable that one hesitates to suggest that there would be a gain in using the abrasive disc. The bandsaws successfully handle plastics, non-ferrous foundry work, stainless steels and even the Nimonic metals. The best thing is for the foundryman to carry out an experiment in his own shops and carefully note down the relevant facts and figures of performance on his own class of work. No one can give categorical pronouncements on this subject.

Neither the abrasive nor the bandsaw manufacturers have supplied statistical comparisons. The abrasive wheel makers suggest that abrasive cutting is quicker and gives a better finished cut than the bandsaw, saves expensive materials owing to the thinner type of wheel used, cuts out saw reconditioning, and saves annealing costs.

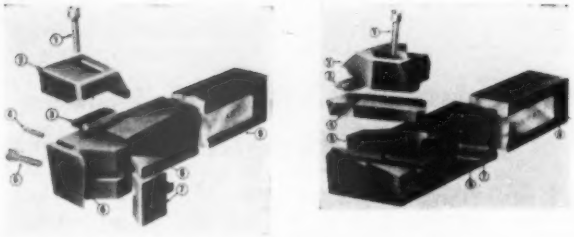
The wheels put forward by abrasive manufacturers for cutting off risers on ferrous and non-ferrous castings are a type of reinforced, depressed centre wheel capable of running up to 16,000 sfpm, and built up of layers of fibre and glass bonded into an abrasive, giving maximum tensile strength and having great resistance to mechanical shock. The wheel face has a radial knurled surface of unique design giving teeth resembling those of a milling cutter.

Flux Washing Process

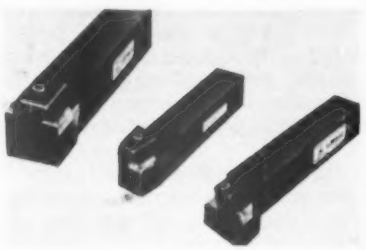
The efficiency of continuous flux washing of molten metal to reserve non-metallic impurities depends on as large a surface area of metal as possible being presented to the cleaning flux. It is to achieve this that the Suprex spreader plate has been designed. This plate, manufactured from carbon-bonded silicon carbide by Morganite Crucible Limited, Norton, Worcester, is suspended in a bath of molten flux and the metal is introduced to the dished centre of the plate. As the metal overflows the plate it is spread out round the circumference as a thin curtain which breaks up as it falls through the flux, thus presenting a large surface area for treatment. The spreader plate and flux are contained in a specially designed Suprex crucible.

Flame Plated Honing Mandrels

Flame plated honing mandrels used in the production of case hardened car transmission gear shift pins last for at least 35,000 operations whereas standard grinding mandrels lasted only 4–5000 operations, due to wear. The only modifications needed were flame plating, and relieving the top of the groove to avoid cutting. The process is carried out at Union Carbide's Flame Plating Department, Millers Road, Warwick.



Top left, Tiptaker toolholder. 1, Main clamping screw; 2, heat-treated, alloy-steel clamp; 3, reversible, bevelled chip-breaker ensures maximum pressure on tip; 4, screw for micro-adjustment of chip-breaker; 5, retaining screw for insert; 6, slot for insert, accurately machined through toolholder body; 7, precision machined, heat-treated alloy steel insert for accurate tip seating and location; 8, triangular (or square) Stag Allenite tungsten-carbide tip; 9, heat-treated alloy steel body, in 3 sizes 1, 1¼, 1½ in. square, left or right hand. Top right, Flowrake toolholder. 1, Main clamping screw; 2, heat-treated, alloy steel clamp; 3, reversible, bevelled chip-breaker ensures maximum pressure on blade; 4, Stag Allenite tungsten-carbide tipped blade; 5, precision-machined slot automatically establishes 15° top rake; 6, screw for micro-adjustment of Stag Allenite tungsten-carbide tipped blade compensates for wear; 7, screw for micro-adjustment of chip-breaker; 8, heat-treated, alloy steel body in 3 sizes, 1, 1¼, 1½ in. square, left or right hand



Tool Tip and Holder Developments

New developments in toolholders and throwaway tips come from Edgar Allen & Co. Limited, the Sheffield engineers and cutting tool manufacturers, who announce two new ranges of toolholder, the Stag Allenite "Tiptaker" (negative rake), using square or triangular tungsten carbide throwaway tips, and Stag Allenite "Flowrake" (positive rake) using inserted tungsten carbide tipped blades. Each range, for which patents are pending, consists of right- or left-hand tools in three sizes—1 in., 1¼ in., and 1½ in. square. Parts are replaceable and tips and blades are supplied ex-stock in all grades of Stag Allenite tungsten carbide. The tips are of standard dimensions, "Utility" or "Precision" ground and both types have a high degree of surface finish which reduces chip pressure and cratering. Like the toolholders, tips are manufactured on modern production lines to a uniform quality of the highest standard.

The Tiptaker negative rake toolholder has only four parts—the alloy steel, 95/100 ton tensile body, the hardened tool steel insert on which the tip seats, the reversible chip-breaker and the hardened, tool steel clamp. The tip seating is ground to ensure flatness, and accurate machining of datum locations for the tip in the body distributes cutting pressures evenly and eliminates pressure points. The tip can be indexed to any of its cutting positions within the manufacturing tolerances. The hardened, tool steel insert counteracts any tendency for chip-erosion of the body.

The new chip-breaker can be reversed when one bevel has become worn. The cutting thrusts pass along the length of the breaker to the bevel of the seating; this resolves a reactionary thrust at right-angles to the bevel and as cutting pressures increase so does the pressure increase between the chip-breaker and the tip, ensuring a secure assembly. Micro-adjustment of the breaker control is infinite and positive, preventing "chip-crowding" and premature breakdown of the tip. This is of particular importance when cutting the higher-tensile materials.

The Flowrake positive rake toolholder supplements the Tiptaker range and is especially suitable when free-cutting conditions are essential or when machining higher-tensile and heat-resistant steels or fragile components where cutting pressures must be reduced to a minimum.

The shape of the inserted tungsten carbide tipped blade can be modified—a feature designed to appeal to the skilled machine operator.

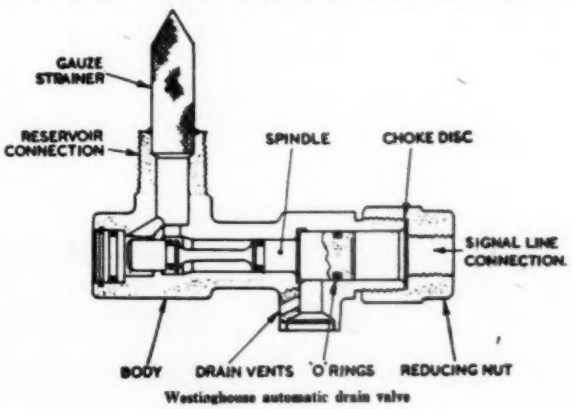
Simplicity is again the keynote for the Flowrake toolholder has only three separate parts—the hardened alloy steel body, the reversible chip-breaker and the clamp which is also made from hardened tool steel. A top rake of 15° is automatically produced by an elongated slot in the toolholder which also gives extra control of the blade. Re-grinding of the blade is thus reduced and confined to retouching the side clearances, cutting edge, nose radius and trail angle; wear on the blade is compensated by a simple screw adjustment. The reversible chip-breaker and its positive micro-adjustment works on the same principle as in the Tiptaker.

Technical literature on all these products is available and Edgar Allen's team of technical representatives, which covers the United Kingdom, is available at short notice to demonstrate Stag Allenite Tiptaker and Flowrake toolholders, tips and blades.

Automatic Drain Valve

An automatic drain valve is a new addition to the extensive range of ancillary compressor equipment made by Westinghouse Brake and Signal Company Limited, Hanham Road, Kingswood, Bristol. The valve can be used extensively in automotive or industrial capacities and is suitable for operation from an unloader or an intermittent pressure line.

Operation depends upon the feeding of a signal pressure to the larger end of the drain valve spindle which incorporates two pistons of differing areas. The signal pressure may be taken from any air line subject to intermittent pressure changes. With the spindle in position furthest from the signal line connexion, water will pass through the filter into the chamber formed between the drain valve body and the spindle neck. Upon release of pressure from the signal line, the spindle will move slowly across to the other end of the drain valve body taking with it the trapped condensate which is then able to drain through the vent holes provided.



Westinghouse automatic drain valve

Production Practice:

Milling Fixture for Equally Spaced Slots Producing a Drum on an Automatic Lathe Lathe Tool Height Gauge

By JOHN WALLER

LONG shafts of the type shown in Fig. 1 do not ordinarily raise problems in the machine shop, but the introduction of three slots in the face of the head requires equipment for holding during milling to ensure correct relationship and the required depth. The chief difficulty is the impossibility of holding the job vertically while cutting due to the length. Milling is the final operation, and location from the 1.25 in. dia with the threads as the holding medium is the obvious choice.

Fig. 2 illustrates the fixture with the component and adaptor in position. The latter A is initially threaded over the part and locates the 1.25 in. dia while also ensuring a longitudinal location from underneath the flanged portion. The fixture base B is fabricated in which an accurately machined 60° V is being incorporated to correspond with the sides of the locating block. Thus at each setting perfect alignment with the machine spindle is assured.

A drawing of the adaptor is given in Fig. 3, to show the groove, which is turned and finally ground in the diameter because this has the important role of obtaining the required setting on each occasion at a certain distance from the cutter face.

The 60° V in the base is channelled away at the bottom to provide both a location and seating for the locating pin C, achieved by milling a slot to mate with a similar tenon on the pin, and the part is seated in the slot sufficiently high to preject into the turned groove in A. Thus the block on being offered to the base must drop over the pin and the position each time is assured first by the V, and then longitudinally by the pin C.

Once the adaptor is in the V a flat plate clamp E is rotated and brought into use. The cutter is a small $\frac{5}{8}$ in. end mill inserted in the arbor and pulled back with the aid of a draw bar, feeding being accomplished in the normal manner by moving the table under power feed with a stop to limit the length of travel.

Cutter depth is of some importance. The figure of 0·200 ± ·002 in. indicates that a setting face for the tool is desirable, and this is accomplished by grinding the face of the fixture an accurate distance from the edge of C.

The placing of the adaptor over the pin and in the V is simple, but when picking up a workpiece some effort is necessary to make sure the adaptor is firmly threaded against the flanged surface. A jamming effect is desirable rather than a tight thread as the latter can make dismantling after the completion of the process rather awkward and will entail a visit to a vice in order to secure sufficient pressure to allow the removal of the shaft. A fairly easy fit is thus deemed a feature of the adaptor with a clearance of about 0·0005 in. over the largest diameter at the rear end, and if these requirements are observed, then loading is simple and takes but a few moments. Failure to thread the adaptor against the flange will result in slots milled too deep and with a wide gap between the flange and adaptor, and could result in the scrapping of a shaft. These points regarding loading are specifically mentioned because the conditions apply generally where this class of locator is employed. Foolproofing is possible by using a pin in front of the head to make it impossible to drop the headed component into place until the gap had been closed.

Fabrication is an asset with all fixtures of this type. The use of a casting would mean that steel surfaces are

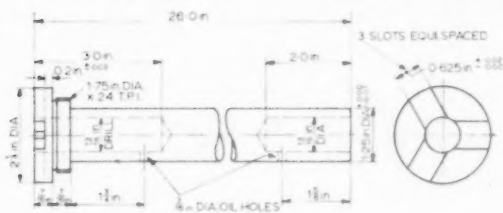


Fig. 1. (top left) Long shafts are awkward to machine on the ends and in this example a special fixture is used for the work

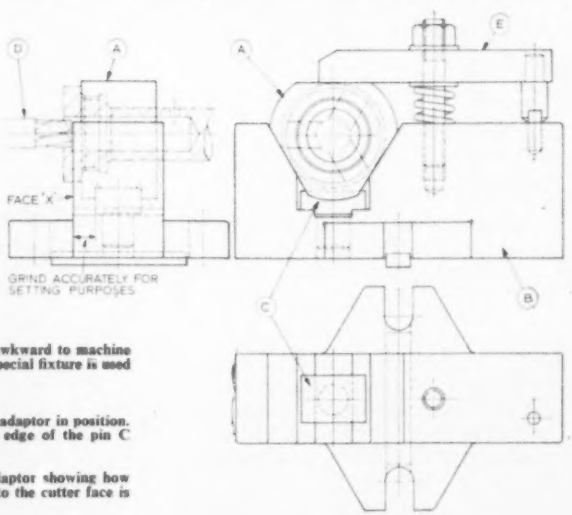


Fig. 2. (right) Fixture showing the adaptor in position. Setting face is obtained from the edge of the pin C

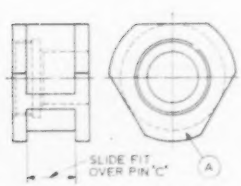


Fig. 3. (left) Locating block or adaptor showing how a longitudinal location in relation to the cutter face is secured

supplied to the V or a complete V attached to the base as iron soon becomes pitted despite every effort to keep the faces clean, and a pattern takes longer than welding pieces of scrap steel together, which was done for this fixture.

It is possible to incorporate a dual location which will allow the machining of two slots together. Two Vs are supplied and the same number of parts mounted as close together as possible. Thus as the cutter passes across two slots at a single setting. This class of location is not suitable for three equally spaced slots as shown here, but is alright for four slots at right angles to each other where the cutter can pass across the face and not strike the back of a hole.

One additional advantage with equipment where the locator is entirely removed from the base is that swarf is brushed easily away and does not collect in inaccessible places, and if necessary increased production is obtained by providing two adaptors—loading one while the other is being used in the fixture. The floor-to-floor time for this operation on these components was four minutes.

Despite the fact standard tools form the greater part of the sets on an automatic lathe their disposition and number can introduce a complicated arrangement of tools and the only limiting factor is the space available in front of the workpiece.

A typical component for such a machine, in this case a Seneca Falls Automatic, is shown in dotted outline in Fig. 4. In the rough state it is a 15 in. dia drop forged steel drum requiring machining on the diameter, front and back of the flange, the large recess and chamfer, the diameter and front and back face of the boss. Altogether nine tools are needed, and without rough machining.

A plan view of the tool layout is illustrated in Fig. 4. The large platen has a series of tool blocks arranged as shown on the power operated cross slide, and after loading and clamping the cycle is gone through, whereupon the chuck opens and the drum is lifted out.

The front and rear flange surfaces are first machined, followed by boring the recess and turning the small boss diameter, the light touch for the chamfering operation being done as the stroke nears completion. Finally the angle at the front of the large recess is obtained by passing a tool into the bore while the cross feed is also progressing—a combination which, if the correct speeds are chosen, will give the desired angle. The hole boring is not part of this tool set.

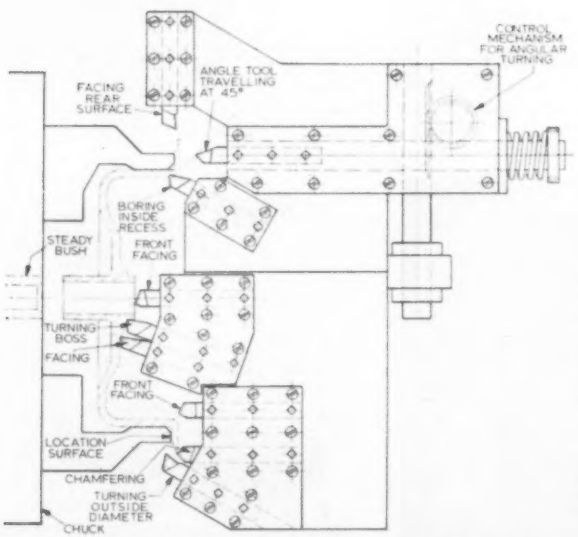


Fig. 4. Nine tools arranged for automatic machining of forged steel drum (shown in outline) including 45° bevel

Where a high degree of accuracy is essential, the complete rough machining of a component is both necessary and highly desirable, particularly if a two-operation layout is required, i.e. including the surface which at the commencement is away from the chuck and subsequently needs machining in a similar manner. Both sides are rough machined on adjoining automatics, and two further machines handle the finishing processes with matching layouts. A set-up of this nature is an ideal site for automation in handling the work at the chuck and transporting the components from one machine tool to another.

Tipped tools in all boxes were arranged in this setting, but an effort was made after the drums had been stamped to remove every trace of scale—not difficult as the shape did not contain awkward pockets, and there were no large fins left after trimming, but some care was required with the pressure exerted at the air chuck as the wall thickness of the drum was not great.

Tool height setting stands are not an innovation but most designs are useful for one machine and a slight variation in the centre height of the lathes—two machines manufactured by different makers but having the supposedly same bed to machine centre dimension—is a typical example where one stand is not suitable despite the fact both machine tools are adjacent to each other in the workshop.

When this situation occurs the adjustable style of stand as depicted in Fig. 5 is a useful and time saving accessory.

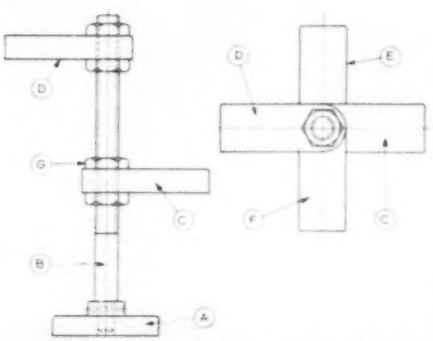


Fig. 5. Centre height setting stand made from scap ends of material

The base A is a mild steel disc. The bar B is about 12 to 18 in. long and threaded to within about 6 in. of the lower end, and a rod $\frac{1}{8}$ or $\frac{3}{4}$ in. screwed Whitworth thread is rigid enough. Four setting bars C are arranged round the central rod and they are eventually set in position and retained by locknuts—there is no need to tap the setting bars as the locknuts will hold them securely.

When the machines have closely matching centre heights the locknuts will interfere with the setting, but by stepping the upper surface of the setting bar, heights as close as only a few thousandths of an inch are possible.

Clearly marking the name of the machine or the operator's name will prevent error.

Machine Tool Record

Co-ordinate Turret Drilling Machines

The David Brown co-ordinate turret drilling machines of the Machine Tool Division of David Brown Industries Limited, Trafford Park, Manchester, are vertical six-spindle machines arranged for fully automatic operation using the E.M.I. Type B.100 control system for table positioning. Two sizes are available, the VTD-30 having a table positioning range of 30 in. (762 mm) × 18 in. (457 mm), and the VTD-45 having a table positioning range of 45 in. (1143 mm) × 25 in. (635 mm). A continuous automatic cycle, programmed by punched tape, is used to control the table and turret position sequences. This eliminates the need for expensive drill jigs and reduces the duties of the operator to the mounting and removal of the workpiece, which is clamped to the table manually or hydraulically. A full range zero shift on both axes is a particularly useful feature, facilitating setting up and programming, where a number of identical components are mounted on the table at the same time.

The VTD six-spindle co-ordinate turret drilling machine

The drill spindles are driven by an eight-speed gearbox housed in the column of the machine and are capable of taking drills up to a maximum of 1½ in. (38 mm) dia. Drill spindle feeds are by hydraulic control, providing a rapid approach to a pre-determined position followed by a fine feed, variable over a wide range. As the turret head indexes, the feed and speed change automatically to suit the pre-set requirements of each spindle.

For ease of operation, all electrical controls are located in one push button panel. Drill speed and feed pre-setting controls are located in the hydraulic valve compartment in the machine column.

The machine can also be used to perform certain milling operations; the tool rapid feeds to the workpiece, reducing to a fine feed where necessary and remains at a pre-set depth until all table movements are complete.

Two sizes of co-ordinate table are available, providing automatic point-to-point positioning by tape control. As with the turret drill, table traversing is effected through recirculating ball screws driven by electric servo-motors which work in conjunction with E.M.I. position analogue units. Tables are readily adaptable for many batch machining operations.

Brinell Projector

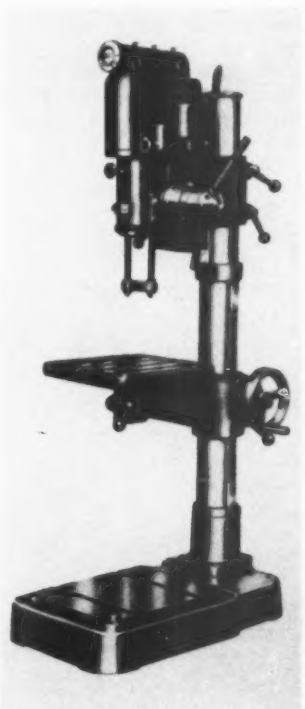
A new projector for measuring the impression made by the Brinell hardness tester has been introduced by Newbold & Bulford Limited, Rodger Street, Grays Inn Road, London WC1. The projector is also useful for measuring any surface within an area of 7m/m dia, which is magnified 10 times on the projector. The cabinets are designed on the unit construction principle, and the instrument is completely self-contained and convenient to use, operating direct from mains voltage by means of the transformer incorporated in the instrument. The cabinet measures 23½ in. × 10½ in. × 20 in.

New Brinell projector

EF1 Drilling Machines

The EF1 1¼ in. capacity drilling machines marketed by Startrite Machine Tool Company Limited, Star Mill Lane, Chatham, are manufactured to Schlesinger limits throughout and a test certificate is issued with each model. The head unit incorporates an all gear drive through an in-built 1¼ hp two-speed fan-cooled motor and six-speed gear box. The gear box is fitted with a patented dial type speed selector which provides rapid and positive change of twelve spindle speeds ranging from 95 to 2600 rpm. To select a speed, the dial indicator is rotated to the right or left until the required position is reached. Rotation of the dial operates a cam shaft and a series of plungers which in turn control lateral movement of the gears. All gear shafts are ball bearing mounted and the gears carefully machined to give quiet, low friction operation. The quill assembly includes a multi-splined ground spindle mounted in Timken taper roller bearings. The spindle is bored No. 3 M.T. and incorporates a travel of 4⅜ in.

Models equipped with power feed include three dial selected feed rates of 0·004, 0·006 and 0·010 in.

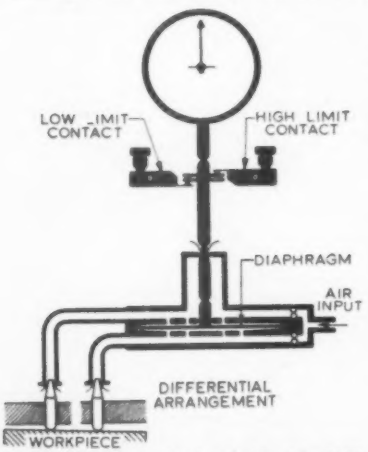


The EF1 Startrite drilling machine

Automatic Valve Inspection

The OMT-Etamic Automatic Valve Inspection Machine has been developed by Optical Measuring Tools Limited to facilitate the rapid inspection of engine valves for dimensional features and for the automatic segregation of those valves found to be faulty. Designed to achieve an inspection rate of 15 valves per minute this machine is, in fact, capable of speeds of 18 per minute. Apart from the loading chute, the machine is fully enclosed and presents an appearance in keeping with its functional purpose.

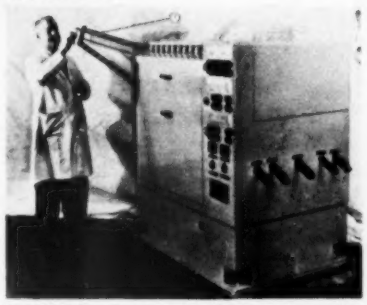
The measuring principle employed is the OMT-Etamic electro-pneumatic system, which in this machine caters for a total of eleven dimensions or features with varying tolerances to be gauged; an important feature is that modifications to any tolerance can be rapidly put into effect. There are four main elements: (1) The loading chute and queueing mechanism, (2) the measuring units and rotary conveyor, (3) the electro-pneumatic gauging system, and (4) the sorting mechanism. Valves are loaded by hand on a gravity chute whence they descend, one at a time, into workholding fixtures mounted on a rotary conveyor and indexed to position under the chute. This conveyor takes the component through three measuring stations and finally the valve is ejected down a multi-channel chute, the sorting gates of which have been set by the electrical system.



Schematic diagram showing the principle of the OMT-Etamic comparator with electrical limit switch system and arranged for differential gauging

The electro-pneumatic system

The comparators to which the feelers from the measuring stations are connected are specially designed



The OMT-Etamic automatic valve inspection machine set and ready for use. Components are being hand loaded on to a gravity conveyor; sorting chutes are located at the side of the unit

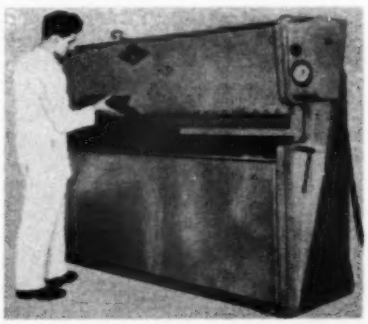
for multi-dimension gauging applications and combine compactness with ease of setting and adjustment. The operating principle of the Etamic "Wheatstone Bridge" system is that filtered air is introduced through jets into two branches which are separated by an extremely supple diaphragm. From the lower or measuring branch air flows through flexible hose to the feeler and escapes to atmosphere through a restriction which is controlled by the position of the feeler plunger. This restriction results in a pressure against the underside of the diaphragm. An equal and opposite pressure is formed in the upper or regulating branch by the variable restriction created by a tapered needle whose lower end rests on the diaphragm.

Thus changes in the size of the component, as registered by the feeler, results in a vertical movement of the diaphragm and the tapered regulating needle automatically adjusts until pressures in both branches are equal. Immediately above the regulating needle is a shaft carrying platinum contacts positioned in such a way that limit switches may be set to operate at the upper and lower tolerance positions. A dial gauge indicates the amount of vertical movement and the dial face is suitably calibrated to show component errors.

In the differential version, equal inlet jets are employed and flexible leads from the upper and lower chambers carry feelers which are exactly balanced to zero against a master setting piece. Dimensional errors in the component cause no disturbance to this zero setting which is only influenced by differential errors which depend upon the mode of employment. This arrangement results in all errors being indicated bi-laterally about the zero and therefore automatic limit settings are possible regardless of purely dimensional errors. OMT-Etamic pneumatic measuring and machine control equipment is marketed by Newall Group Sales Ltd., 142 Bridge Road, Maidenhead.

Hydraulic Press for General Work

Over the last three years Gus Lee & Boswell Limited, South Denes Road, Great Yarmouth, have developed and used in their own works a 100-ton hydraulic press, and they have now decided to introduce it to the market. It has been designed to meet the requirements of the small general engineer, like themselves, who has a variety of one off and/or batch work jobs involving plate fabrications, bending, flanging, edge breaking etc. but who does not have large quantity demand on the scale for which a fully automatic brake press would be required. This press has the virtues of simplicity of operation, versatility, wide capacity and an economic price, It has the beneficial effect of widening the range of production and capacity, saving time and yet not involving a large capital outlay. The machine is provisionally priced at £975 complete ex works.



The new 100-ton hydraulic press designed for the small general engineering works

Reversing Drills

Three new heavy duty reversing drills from Black & Decker Limited, Harmondsworth, are the 575 ½ in. price £55, the 576 ⅝ in. price £65, and the 644 ¾ in. Price £80. They are provided with Key-Drive geared chuck and key to give positive drive in reverse. Change from forward to reverse is by a reversing switch ring. In reverse the drills can do tube expanding, tapping, and backing-out. The motor is of 1150W input.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Tracing Accidental Tripping of Over-current Devices

The most common form of protection afforded to an electric motor as a safeguard against damage resulting from sustained overloading is an over-current release. This device will operate to disconnect the motor from the electricity supply in the event of sustained overloading causing excessive current to be maintained in the motor windings, which would otherwise result in overheating and ultimate burnout of the windings. The device has an adjustable current value setting and has to be set to operate at a suitable current, i.e. the maximum current at which the motor will operate continuously without overheating.

It is important that such over-current releases be checked periodically to ensure that they continue to be in satisfactory working order and that the trip setting remains adequate for the required protection of the motor. It sometimes happens that accidental tripping of the motor circuit-breaker takes place from an unknown cause, and in such cases where repeated trouble is experienced, there may be a tendency to prevent persistent repetition by altering the trip setting and increasing the value of the current at which the release is set to operate. This is the wrong procedure to adopt in such cases, and it is essential that the cause of the trouble be traced so that a suitable remedy can be effected.

A common example is the effect of vibration on the circuit-breaker tripping mechanism, whereby premature operation of the mechanical release is brought about. Portable equipment is vulnerable to this trouble, and it may also be experienced with starters mounted on walls which are subject to vibration transmitted from adjacent machinery such as reciprocating plant.

An interesting case in the writer's experience concerned an oil circuit-breaker controlling a large motor driving two pumps in connexion with a hydraulic system. A burnout of the motor windings occurred and systematic investigations revealed that the primary cause of the trouble lay in the controls of the hydraulic system whereby faulty operation had resulted in a build-up of the hydraulic pressure with consequent stalling of the motor. The latter was controlled by an oil circuit-breaker incorporating a solenoid-operated closing mechanism, and it was evident that the over-current release, although apparently set to function on slight overloading of the motor, had failed to open the circuit-breaker. It was established that the electrical circuit of the over-current release had functioned to initiate the tripping of the circuit-breaker, but the final mechanical release had failed to operate, and in consequence the circuit-breaker contacts remained closed. The stalling current was therefore maintained in the motor windings until burnout occurred, and the ultimate failure of the winding insulation resulted in the flow of a heavy fault current which brought out the main electricity supply circuit-breaker.

The reason for the non-operation of the final mechanical release was not, at first, apparent, but tactful enquiries elicited the information that prior to the breakdown, trouble had been experienced in the form of accidental tripping of the circuit-breaker for no obvious reason, and to eliminate the possibility of a recurrence of this trouble the degree of sensitivity of the final mechanical release had been substantially reduced. This was readily achieved by the tightening of a nut against a spring in compression, whereby the sensitivity of the tripping mechanism was altered. The adjusting nut had been tightened to such an extent that the tripping lever could not disengage from its retaining pawl, and this had rendered the final mechanical release inoperative.

It was, of course, necessary to locate the cause of the accidental tripping of the circuit-breaker and this was found in the solenoid-operated closing mechanism. The closing of the circuit-breaker contacts was effected by a moving iron core in the solenoid which was attracted towards a fixed iron core. The moving core was normally adjusted so that it did not actually come into contact with the fixed core. It was, however, found that the adjustment had been altered with the result that, on closing the contacts, the moving solenoid core struck the fixed core a sharp blow. This mechanical shock was transmitted to the tripping mechanism and was sufficient to displace the tripping lever from its retaining pawl under normal setting conditions whereby the tip only of the tripping lever rested on the pawl. The remedy, of course, was to re-adjust the moving solenoid core to its correct position and thereby eliminate the primary source of the trouble.

The Graphs of $y = x^n$

In considering the graphs of $y = x^n$ for integral values of n, it is well-known that for positive values of x the graphs are all in the upper quadrant whereas for negative values the graphs are in the upper quadrant for even values of n and in the lower quadrant for odd values. (Fig. 1). This may seem strange or discontinuous but it is not generally appreciated that if the full range of complex numbers are considered, the results are more logical. In considering the graphs of the equations, it is more convenient to regard $x = \sqrt[n]{y}$ but it will be realized that the results apply in the original form of the equations.

Referring to the three-dimensional diagram in Fig. 2, the real values of x and y will be considered in the usual directions but imaginary values will be considered in the z direction as indicated. The graph of $y = x$ is then a straight line through the origin with no imaginary parts.

Referring to Fig. 3, for the graph of $y = x^2$ the positive values of y give a parabola as usually drawn but the negative values are wholly imaginary parabolas at right angles thereto. On the other hand, for the graph of $y = x^3$ as shown in Fig. 4 there are three limbs equally spaced in the positive portion and three in the negative portion but showing as a continuous curve in the xy plane as usually drawn. If $y = x^4$, however, (Fig. 5) there are four equally spaced graphs in the positive portion and four in the negative.

Thus for all the cases there are

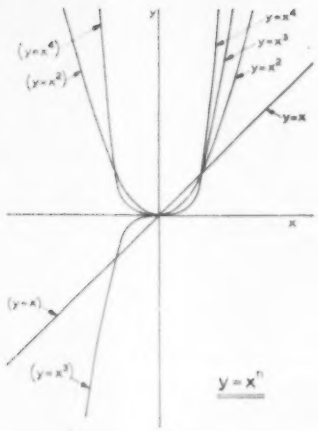


Fig. 1

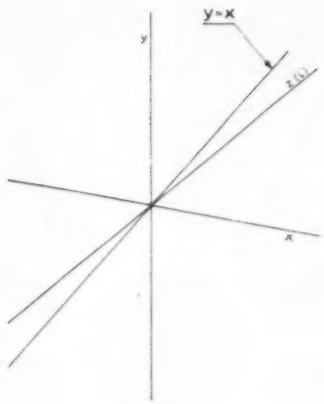


Fig. 2

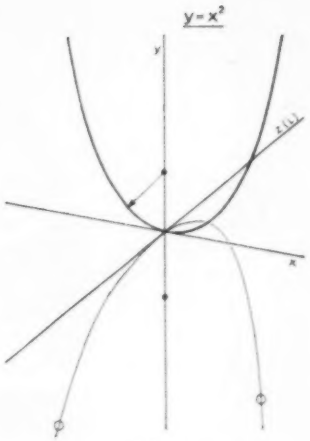


Fig. 3

n limbs equally spaced in the positive portion, one being in the positive *xy* plane, and an equal number in the negative portion intermediately disposed between those of the upper. It follows, that if only the *xy* plane is considered the graph remains in the upper quadrant if *n* is even but proceeds to the lower if *n* is odd.

Curiously, this gives the answer to another associated problem. If the general case of $y = x^n$ is considered and the curvature calculated, at $x = 0$ the result is, in general, 0 (or radius of curvature infinity). But in the special case of the parabola $y = x^2$, the radius of curvature is 1/2. The question arises, why should a parabola be a special case? Reference to the illustrations gives the answer. Fig. 5 shows there are two centres of maximum curvature for the real graph of $y = x^4$ and eight ($2n$) in all. Fig. 4 shows there are similarly two for $y = x^3$ and $2n$ in all. But for the case of the parabola (Fig. 3), the simplest curve, the two real centres coincide on the *y* axis giving a finite curvature and radius of curvature at the origin.—W. H. Sheppard, B.Sc.(Eng.).

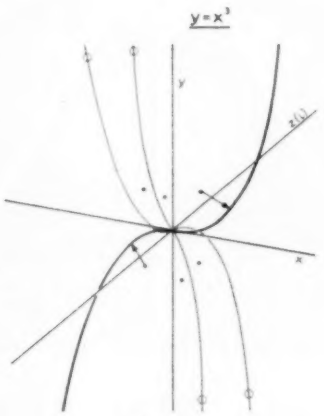


Fig. 4

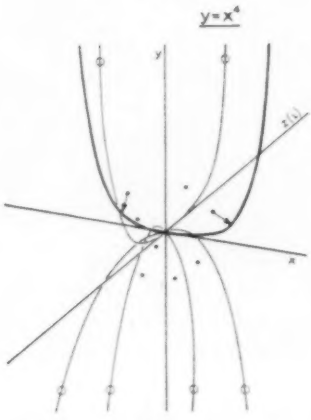


Fig. 5

Lubrication of Aluminium Rolling Mills

Major problems which arise when the lubrication systems of both hot and cold aluminium rolling mills are being planned include the complete avoidance of staining the metal. This and other considerations were accentuated by the design of two new rolling mills now installed as part of the £7 million expansion scheme at the Kitts Green Birmingham works of James Booth Aluminium Limited. The designs of both the 72 in. four-high cold mill and the 148 in. four-high hot mill incorporate—for the first time in Britain—the provision of oil mist lubrication of the roll neck bearings.

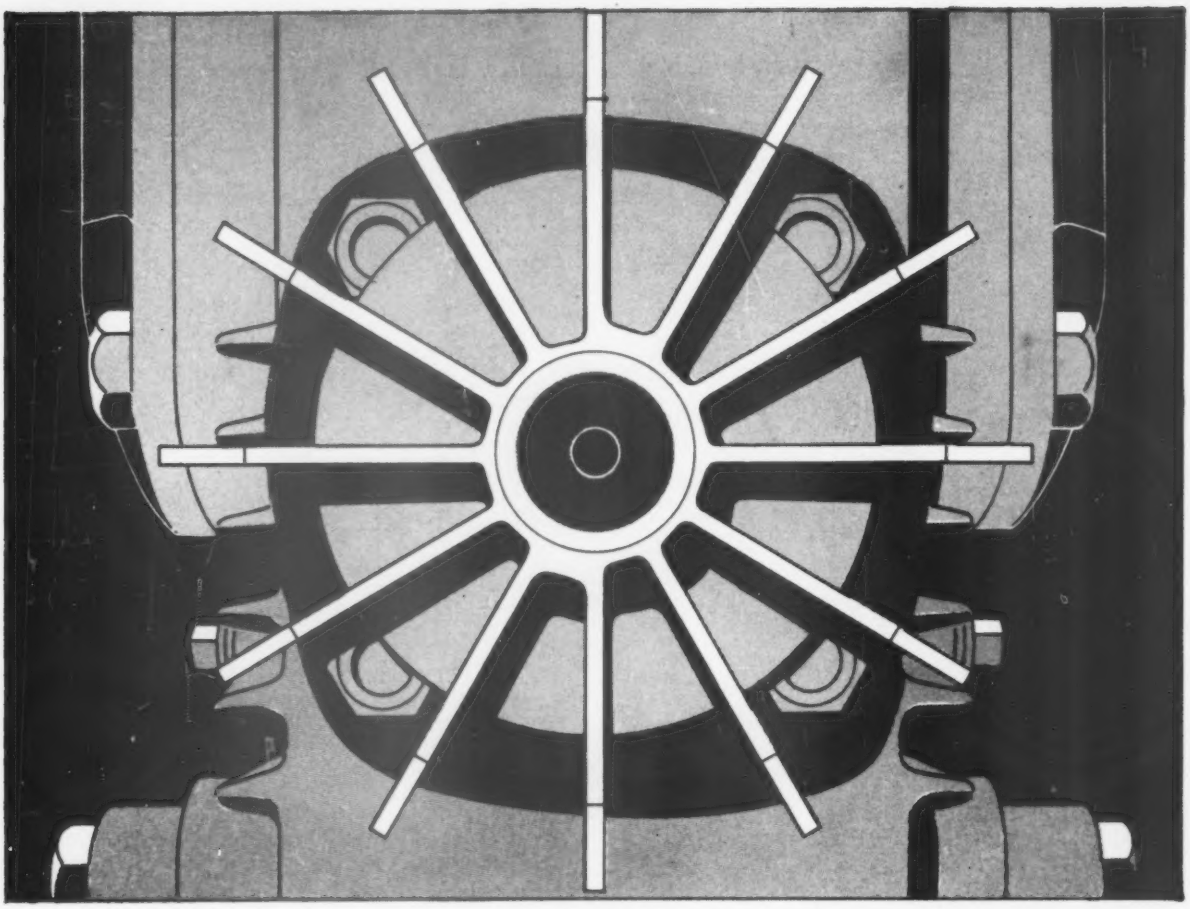
Work rolls and back-up rolls in both mills are fitted with four row Timken tapered roller bearings and the many advantages of oil mist lubrication are further enhanced by the simplicity of installation and maintenance of the systems.

Shell-Mex and B.P. Limited were awarded the contract for this work by James Booth Aluminium Limited, and this lubrication of equipment other than the roll neck bearings—perhaps the most important being the mill gear boxes, one of which required an initial fill of 1200 gal. Two grades of the heavy duty leaded Shell Macoma oil have been used for the gear units and Shell Omala Oil 37 for the oil mist systems. For the large number of other rolling bearings incorporated in these mills Shell Alvania Grease EP 2 has been used, many of the bearings being fed through a Farval centralized grease system.

Rating of Heat Exchangers

Shell-and-tube heat exchangers are widely used in industry, but their accurate rating still presents some difficulty to the designer. A step-by-step analysis is to be preferred when performance has to be predicted accurately. With this technique it is necessary to assess the various flow paths through the exchanger, to determine, for example, the leakages that take place between baffles and shell, and between baffles and tubes. In a survey given in *NEL Report* No. 45* (Shell-side heat transfer and pressure drop with turbulent flow in segmentally baffled shell-and-tube heat exchangers—a survey, by W. H. Emerson), the methods used in estimating the effect of these flows on the pressure drop and heat transfer are compared.

* Available from the National Engineering Laboratory, East Kilbride, Glasgow.

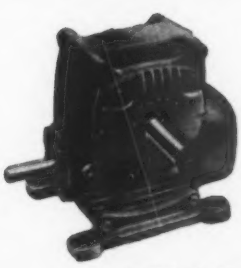


This is the reason why NEW 'ADAPTABLE' RADICONS have better than ever thermal ratings

This is the fan which David Brown have incorporated in the new Radicon 'Adaptable' range. The controlled flow of air increases heat dissipation, giving 50% more capacity over units of similar size without fans.

The 'Adaptable' range gives unequalled versatility of mounting because of its detachable feet. Seven sizes from $1\frac{1}{8}$" to $3\frac{3}{8}$" cover drives up to 10 h.p. Leaflet E.387.125 gives complete information on sizes, performance and selection of the 'Adaptable' range.

For drives over 10 h.p. the SOLID FOOT RADICONS will meet your other requirements.



Both the design and name of the 'Radicon' are registered.

DAVID BROWN

THE DAVID BROWN CORPORATION (SALES) LIMITED

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In Brief . . . .

Notes on New Materials, Plant and Machinery

Low Headroom Hoist.—Loads up to 5 ton can be dealt with by the sturdy, low-priced "Electralift" hoist newly introduced by Fellows Bros. Limited, Box 9, Cradley Heath.

Armoured Hose.—"Sureflex" hose made by The Lunken Company Limited, Gander Green Lane, Cheam, has a neoprene or nitrile rubber core covered with galvanized steel braid and flat metal strip.

Pancake Motors.—New Pancake motors introduced by the General Electric Company Limited, Witton, Birmingham, are specially for integral machine tool drives.

Rivet Contacts.—A new range of silver-faced rivet contacts has been introduced by Johnson, Matthey & Co. Limited, 73 Hatton Garden, EC1.

Pushbutton Switch.—Square-D Limited, Cheney Manor, Swindon, have added a single-unit, maintained-operation switch to their heavy duty oil-tight range.

Stop Valves.—¼ in. to 2 in. B.S.P. cam-action rubber-element Claudo Swedish-made stop valves supplied by Air Automation, 26 Sharrocks Street, Wolverhampton, are claimed to give 100,000 leakfree cycles.

Hopper Discharge.—Christy & Norris Limited, Chelmsford, have introduced the "Speedigate" electro-pneumatically operated hopper discharge sliding door.

Separators.—Oily water separators made by Rellumit (London) Limited, Palmer Street, SW1, have been approved by the Ministry of Transport for installation in ships.

Zinc Plating.—A fully automatic zinc plating plant made by Electro-Chemical Engineering Company, Sheerwater, Woking, has been installed in the Fiat factory at Turin.

Marking Pen.—For marking tools, components etc., Cushman & Denison Company Limited, Moland Street, Birmingham 4, have introduced a pocket-sized pen which uses a special ink.

Lorry Loader.—An elevating loading platform which collapses and is housed under its lorry is a new addition to the aids made by Access Equipment Limited, Mayland Avenue, Hemel Hempstead.

Hoist.—Equipment which makes overhead installation a one-man job is the Alivater made by Access Equipment Limited, Mayland Avenue, Hemel Hempstead.

Loading Shovels.—A range of four-wheel drive loading shovels designed to be competitive in the international market has been introduced by Chaseside Engineering Company Limited, Station Works, Hertford.

Hydraulic Pump.—A low priced hand pump, the Presto GR1, for 2000 psi, has been added to the range made by Chamberlain Industries Limited, Argall Avenue, London E10.

Automatic Lidding.—A Proximator electronic senser made by Electronic Machine Controls Limited, Thornton Heath, Surrey, is built into the can lidding machine made by DICO Limited, Guildford.

Engineering Capacity.—The newly extended premises of P. M. Pathe (Engineers) Limited, Broomhall Street, Sheffield 3, enable them to offer greatly increased facilities for finishing heavy forgings and castings.

Pipe Inspection.—A special TV camera has been built by EMI Electronics Limited, Hayes, for inspecting the insides of pipes and sewers.

Pneumatic Valves.—Qualter, Hall & Co. Limited, Barnsley, have a new electrically operated pilot valve for remote control.

Tile Handles.—The American "Skroo-Zon" file handle is available from Eric H. Bernfield Limited, 282 Kingsland Road, E.8, at 20/- to 30/- per dozen.

Gin Pole.—The 120-ft, 20-ton stacks at the BP Kent refinery were lifted into position by Wimpeys, using a single 160-ft Butters gin pole secured by Waite's Molex earth anchors.

Trucks.—The American Barrett-Cravens battery electric industrial truck is to be made by Brush Electrical Engineering Company Limited, Loughborough.

Relays.—B. & R. Relays Limited, Harlow, are in full production on a complete range of PO 600 relays in three types—100, 250 and 650 volt.

Balancing.—A service for electronic dynamic balancing is now available from Metaducts Limited, Catherine Wheel Road, Brentford, components of 15 to 3000 lb can be handled.

Building Blocks.—The Pointer Group, Norwich, have developed a machine for making peg-and-hole interlocking concrete building blocks.

Density Control.—Automatic control of density of liquids and slurries in process has been improved by a new continuous controller developed by Blaw-Knox Chemical Engineering Company Limited, 20 Eastbourne Terrace, W2.

Quiet Transformer.—Brush Electrical Engineering Company, Loughborough, have a new transformer housing so effective that transformer noise cannot be measured against background noise.

Plating.—The manufacturing capacity of Barking Brassware Company Limited, Barking, has been greatly increased by a new boiler house and canning plating shop.

Feed Mill.—The new X-mill made by Christy and Norris Limited, Chelmsford, offers improved maintenance facilities and simple replacement of screen and bearers.

Voltmeters.—A new range of expanded scale voltmeters for critical monitoring on complex circuits is being produced by The English Electric Company Limited, Strand, WC2.

"Oylsolv".—This is the name of a new water soluble grease and oil solvent for removing caked oil and sludge, marketed by R. & J. Bow Limited, 21 West Nile Street, Glasgow.

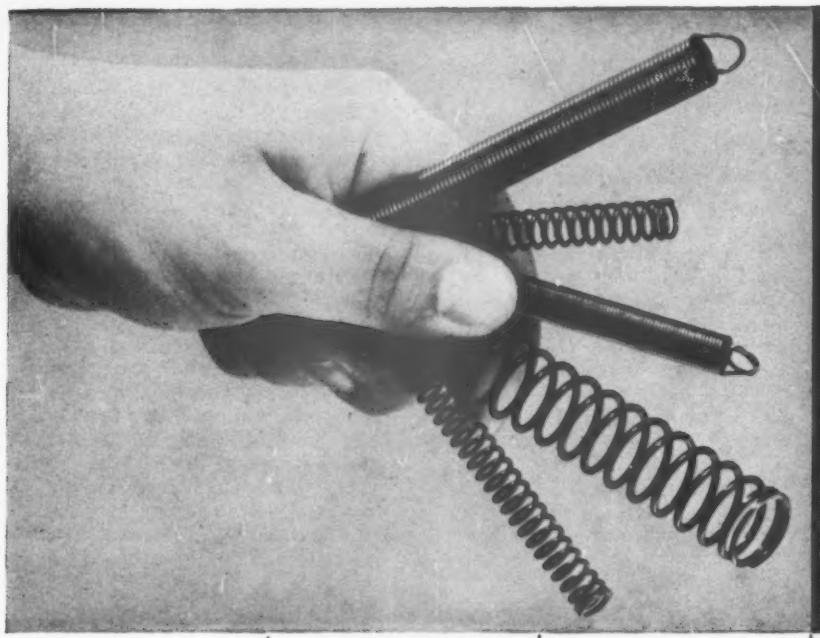
Containers.—Collapsible returnable containers in standard sizes or made to measure are available from Reynolds (Packaging) Limited, Barking.

Ford Powered Paver Finisher.—The latest paver finisher announced by Blaw Knox is exclusively powered as are all Blaw Knox Pavers, by the Ford 592E 4-cylinder industrial diesel engine developing 63 bhp at 2250 rpm (B.S. overload).

Tape Controlled Drilling Machine.—A new tape controlled drilling machine has been introduced by Midgley & Sutcliffe Limited, Leeds, who manufacture the Richmond range of machine tools. It uses numerical control by information coded on punched tape.

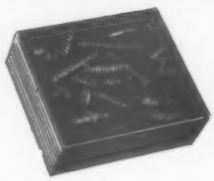
Low-friction.—Polypenco Limited, Welwyn Garden City, announce a new low-friction material for high temperature use under the trade name "Polymet" A-G, a metallic "alloy" of silver and solid self-lubricating plastic.

Equipment Wires.—Tygadure Limited, Littleborough, announce a new ptfe insulated wire using silver plated copper conductors and braided screen, and new cementable or pottable wires.

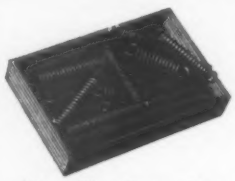


Let Terry's assorted springs help with your experiments

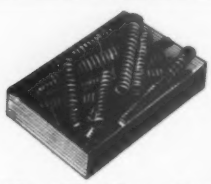
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-**



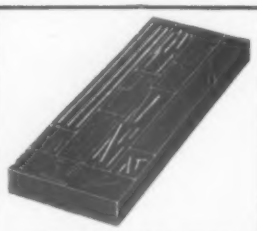
No. 757. Extra Light Compression, 1 gross Assorted, ⅛" to 7/16" diam., ½" to 2½" long, 27 to 19 S.W.G. **18/-**



No. 753. Three dozen Assorted Light Expansion ¼" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. **12/-**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., ¼" to ½" diam. **7/6**



No. 1217. One gross Assorted springs. **45/-**

No. 758. Fine Expansion Springs. 1 gross Assorted ¼" to ½" diam., ½" to 2" long, 27 to 20 S.W.G. **18/-**

Pick the spring you want, when you want it, from our fine range of small Boxed Assortments of Experimental Springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a Spring problem our Research Department will be pleased to put their long experience at your disposal.

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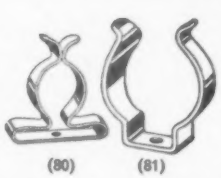

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books

Principles of Self-organization. Edited by Heinz Von Foerster and George W. Zopf Jr. London, 1962: Pergamon Press Limited, £5-5-0 net (by post £5-7-3) 541 pp. $5\frac{1}{2} \times 8\frac{3}{4}$ in.

This volume contains the Transactions of the University of Illinois Symposium on the subject of the book held in 1961 and sponsored by the U.S. Office of Naval Research. The basis of the study is computer science and technology, but the detailed subject matter goes all the way from groups of three people playing games to a complete cybernetic factory (i.e. entirely automatic and without human operatives). The maze of subject matter in between has much to do with theorems and problems of the neuron (the basic element in a nerve or computer network), with logics, orderly functions, integral geometry, brain models, distributed memory, and the like. Titles such as: "A Proposed Evolutionary Model", "Principles of the Self-organizing System", "How a Random Array of Cells Can Learn to Tell Whether a Straight Line is Straight", "An Approach to Automatic Theory Formation", and "A Logical Program for the Stimulation of Visual Pattern Recognition", give clues to the variety and scope of the topics dealt with.

Ever since computer theory suggested a picture of the working of the human brain, and computers were found to be capable of simulating human learning and reasoning processes, the more advanced section of the computer scientific community has been speculating on and working towards machines that would be capable of what is here described as "self-organization". Now that components, with the aid of the transistor and, more particularly, solid circuitry, have been greatly reduced in dimensions, the probability of building machines with remarkable capabilities becomes a near reality. There is still a long way to go before the compactness of the human brain is matched so far as capacity is concerned, but when it is possible to have one computer equal to a number of brains, each of genius size and/or organization, and the whole of human knowledge can be fed into it, then to say the least it will be interesting to see what answers it produces to the massive problems that confront thinkers in science, philosophy, technology, sociology and politics.

Hydraulics in Mechanical Handling. By J. R. Fawcett. London, 1962; The Trade & Technical Press Limited. £2-2-0 net (by post £2-3-1) 159 pp. $7\frac{1}{4} \times 9\frac{5}{8}$ in.

Hydraulic power, and with it a range of power using machinery, had a considerable impetus from the inventions of Lord Armstrong, from about 1846 onwards, in the last century. Subsequent development was for a long time comparatively slight, but in the last ten years or so new life has been injected into hydraulic technology in a number of directions, and particularly in the one with which Mr. Fawcett deals in his book. The advantages of hydraulic power in machine design lies in its flexibility and accuracy of control, its reliability, and not least its economy (which was not always a strong point). In this book the author describes all the components and methods used today and presents also a collection of appropriate data which will make the book useful in both works and design offices.

Progress in Nuclear Energy. Series V. Metallurgy and Fuels. Vol. 3, Basic Materials and Phenomena, Vol. 4, Metallurgy and Nuclear Reactor Components; edited by H. M. Finniston and J. P. Howe. London; Pergamon Press Limited. £5-5-0 each net (by post £5-7-3 each). pp. 1-476 + XX and pp. 477-910 + XX. $5\frac{3}{4} \times 9\frac{1}{4}$ in.

These two volumes form part of a major work consisting of twelve series of volumes which cover every aspect of work and development in nuclear energy. Vol. 3 contains 28 contributions on the metallurgy of nuclear fuels and reactor materials, including certain aspects of powder metallurgy, metal forming, the interpretation of radiation effects, structural changes occurring during irradiation, damage to graphite, radiation stability of non-metallic structures, point imperfections, applications of neutron diffraction. There are 24 papers in Vol. 4 among which are contributions on techniques used at Dounreay, Calder Hall, Hunterston, and at several places abroad. Cladding and control materials are also dealt with and there are contributions also on evaluation, corrosion, and irradiation swelling.

Theory of Elastic Thin Shells. By A. L. Gol'denveizer. Translated from the Russian by G. Herrmann. London; Pergamon Press Limited £5-5-0 net (by post £5-7-3). 658 pp. $6 \times 9\frac{3}{4}$ in.

Arising out of work in aeronautics and astronautics there has been a great (rather surprisingly great) interest in shell theory in structural analysis (which, incidentally is being found useful in other applications). While there is a steady flow of papers there are, however, few comprehensive treatments. This is one of them and it is distinctive in that it presents rigorous mathematical foundations and also indicates in detail useful approximate methods of solution. In connexion with the latter feature the author has added, for this English edition, a supplement which presents the most recent advances in the method of asymptotic integration.

The book opens with a general formulation of the theory of shells and the relevant equations, and goes on to a detailed examination of membrane theory for approximate analysis. Then methods of analysis of circular cylindrical shells with the aid of trigonometric series are considered and brought to the stage where the results can be used to verify general approximate methods. Next the approximate methods are justified mathematically, and finally these methods are formulated for a number of cases, estimates being given of asymptotic errors.

Fourth ENEA Report.—The fourth report on the activities of the O.E.C.D. European Nuclear Energy Agency covers the period from July 1961 to June 1962, and records the progress of ENEA's three joint undertakings (the Eurochemic Company for processing irradiated fuel, and the Halden and Dragon reactor projects); examination of various ship and reactor combinations for a possible joint construction project; steps towards closer inter-

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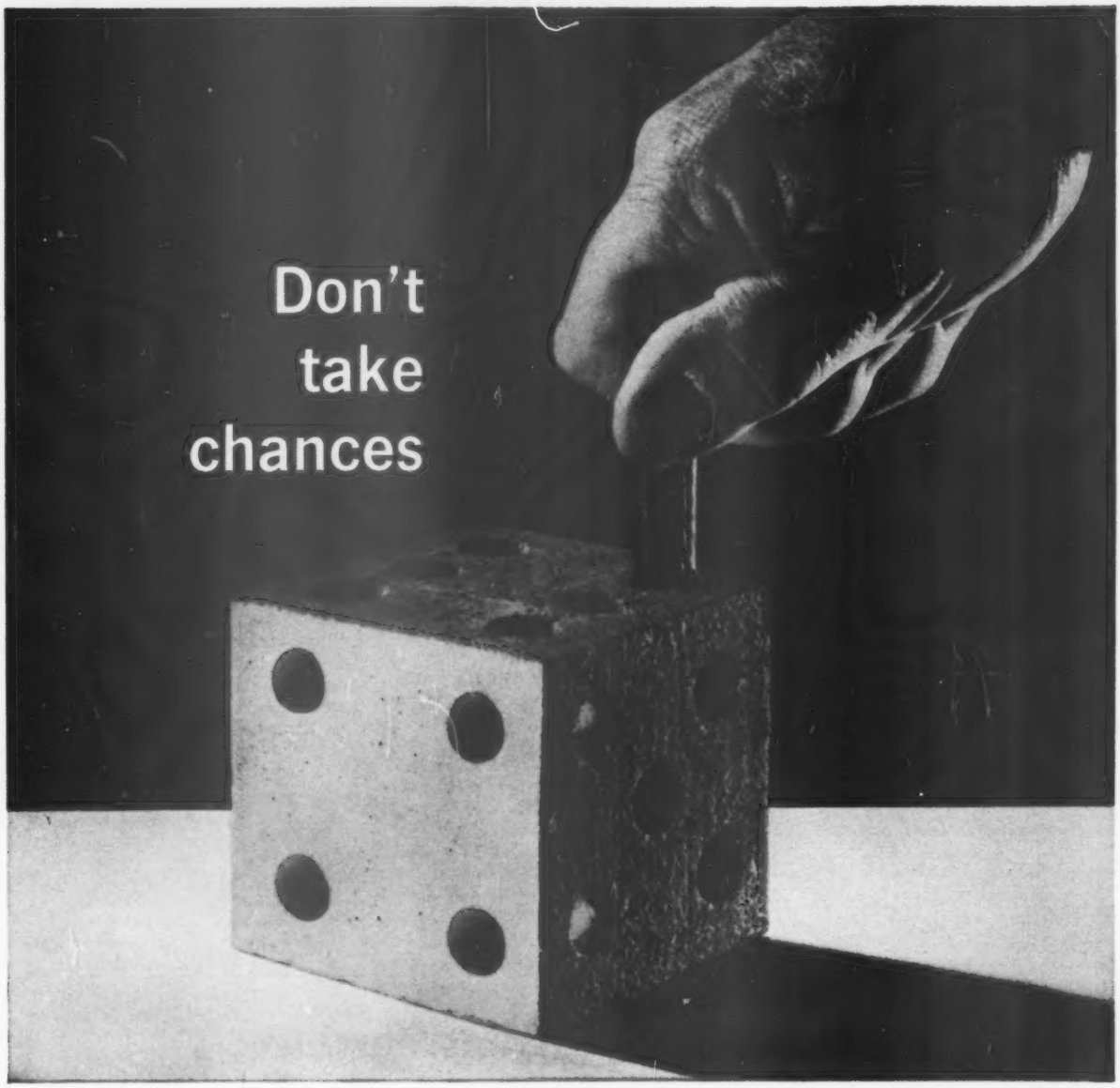

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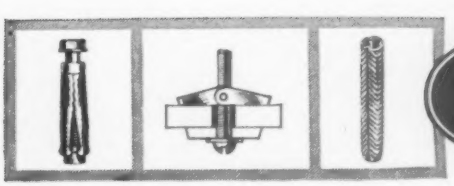

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national scientific co-operation (particularly in connection with research at very high neutron fluxes); the setting up of a European-American Committee on Reactor Physics; and a proposal for an international research programme on the application of irradiation to food preservation. The report also gives details of the agency's continuing work towards uniform European regulations governing the legal and administrative aspects of nuclear energy, and predicts that by 1968 the proportion of Europe's electrical generating capacity supplied by nuclear installations will be approaching 3%, or some 7000 electrical MW.

Symposium on Electroforming.—The American Society for Testing and Materials, 1916 Race Street, Philadelphia 3, Pa., U.S.A., has just issued a volume, price prepaid, $6.25, "Symposium on Electroforming—Applications, Uses, and Properties of Electroformed Metals" (STP 318). Electroforming is the art of producing or reproducing metallic objects by electrodeposition upon a master form which is then removed in whole or in part. The process was employed extensively during World War II for making large 60 in. reflectors, antenna masts and pitot tubes for aircraft, and large, accurate moulds for explosives. Current uses are linear accelerator parts, radar and electronic components, complex airframe skin sections, and shipboard radar antenna feeds.

A Unique Association.—Associated British Machine Tool Makers Limited, 17 Grosvenor Gardens, London SW1, have issued a 12-page brochure describing how this unique selling association was started and the machine tool services it offers to the metalworking industries throughout the world. Formed in 1917 as a joint selling venture by a group of non-competitive machine tool builders, ABMTM is now a powerful international sales organisation representing its member companies, The Butler Machine Tool Company, The Churchill Machine Tool Company, Kendall & Gent, John Lang & Sons, J. Parkinson & Son (Shipley) and H. W. Ward & Co., in addition to acting as the sole selling agency for AMT (B'ham), Clifton & Baird, Crow, Hamilton & Co, Fairbank Brearley, Hayes (Engineers) Leeds and J. L. Jameson. This brochure includes more than fifty illustrations of machines which have been selected to show the very extensive range manufactured by these companies, while an index includes more than 140 items.

Stacking Materials.—Stacking materials is not just a matter of piling things one on top of the other. Stacks must be built in such a way that they cannot collapse and so that they can be broken down in complete safety by those working on them. Apart from the planning, siting and construction of stacks, there are many other factors which have to be taken into account; these include the protection of stacks in the open air; stacking near cranes, roads and railway lines; excavations near stacks; and fire precautions. The new edition of "The Stacking of Materials" covers all these aspects of stacking in detail, and the principles involved in stacking of specific types of goods are discussed and illustrated. Copies are now available from the Service Department, RoSPA, 52, Grosvenor Gardens, London SW1. price 4s. 6d. (members 3s. 0d.), Reductions for quantities.

Lighting and Productivity in Factories and Offices.—The British Lighting Council (16-18, Lancaster Place, London WC2), in a new book of this title, have posed themselves the task of answering the questions that factory managements most frequently ask about lighting to-day. Will it help productivity? How much light ought there to be? Should it be fluorescent or filament? Is local or general lighting needed? And so on. The text is full of comment and helpful illustration on all these points. In addition, it covers the essentials of principles and technique which the electrical man or architect would like to have to hand when he comes to discuss with managements how to provide the better lighting called for.

Resistance of water fittings.—The No. 15, Summer 1962, issue of the Copper Development Association's journal (55 South Audley Street, London, W1) contains a table of frictional loss in copper compression and capillary pipe fittings from ¼ to 2 in. dia and for water temperatures of 60° and 150°F. A more extensive table is to be made available later.

Bridge Bearings.—Technical Bulletin No. 7 from The Natural Rubber Producers' Association (19 Buckingham Street, London, WC2) is by P. B. Lindley and deals with the design and use of natural rubber in the bearings which allow for the thermal expansion and contraction of bridges. Rubber bearings can be designed which are sufficiently soft horizontally to impose only minor loads on the supports but which are sufficiently stiff vertically to prevent appreciable changes in height under changing load.

Manchester Directory.—The Manchester Chamber of Commerce has issued its 1962/3 directory of members. There are alphabetical and classified sections, the latter providing a guide to manufacturers and services for a great range of products.

1961 Maintenance Conference.—A full report is now available of the 1961 National Maintenance Conference. The 200-page bound volume contains complete texts of all the papers together with a report of the discussions, also a verbatim account of the opinions and ideas expressed at the twelve discussion sessions.

New Standard

Unified screw threads (B.S. 1580). Price 30/- net.

The International Organization for Standardization has recommended that the Unified system of screw threads be adopted as the international screw thread system in inch units, in parallel with a similar ISO metric system. This British Standard has now been revised to accord with the method of presenting data used in the latest revision of the American Unified screw thread standard, ASA B1.1-1960. The standard provides for a Unified coarse thread series (designation UNC) from ¼ in. to 4 in. dia, a Unified fine thread series (designation UNF) from ¼ in. to 1½ in., and a Unified extra fine thread series (designation UNEF) from ¼ in. to 1 1/16 in. A standard constant pitch series arranged to give a graduated system of diameter pitch combinations is also included. The basic design forms of the thread are defined and tables of basic dimensions, limits and tolerances for all the diameter/pitch combinations in the UNC, UNF, UNEF and the standard constant pitch series are given for the three classes of internal and external threads. The bases of tolerances for Unified screw threads ¼ in. and larger are included as an appendix, as are details of fine sizes below ¼ in. dia for attachment purposes and for general use in the aircraft industry.

British Standards Institution, 2 Park Street, London W1.

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DO YOU ACCEPT 'ROUTINE' BREAKDOWNS AS INEVITABLE?

Take any heavily stressed bearing—there'll be several in your works. Pressure, heat, overloading, or the washing action of water or chemicals breaks down the lubricant cushion between bearing surfaces. Rapid metal to metal wear takes place and the bearing fails—so frequently that *you now accept it as a normal, inevitable rate of replacement.* Call it component failure? That's the outcome certainly—*but the cause is lubrication breakdown.*

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Problem: Over loaded gearbox running hot, probably 170-180°F—too hot to be touched.

Solution: Anti-Scuffing Oil added to gearbox sump. Temperature reduced 'almost immediately' to about 120°F —no further trouble.

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BUSINESS & PROFESSIONAL

Personal

STOTHERT AND PITT LIMITED announce that **Major-General G. L. Watkinson, D.S.O., D.L.,** has resigned as joint managing director as from December 31, 1962 but will retain his seat on the board. **Mr. Joseph Gourlay** will continue as managing director from January 1, 1963. **Dr. W. Darlington, M.B.E., M.Sc.(Eng.), D.I.C.,** of AEI Limited has been appointed deputy managing director and will take up his duties early in the New Year.

Mr. F. W. Robinson, assistant managing director of Thos. W. Ward Limited, Albion Works, Sheffield, has been appointed chairman and managing director of George Cooper (Sheffield) Limited, Sheffield, and a director of Town Woodhouse Limited, Brighouse, and John Smith (Keighley) Limited, Keighley, all member companies of the Ward Group. **Mr. G. Stuart Wood,** director of Thos. W. Ward Limited, has resigned his directorship of John Smith (Keighley) Limited, and has been appointed chairman and managing director of Town Woodhouse Limited, Brighouse.

Mr. Clifford W. Allin was recently appointed to the board of S. Briggs and Company Limited of Burton-on-Trent, manufacturers of brewery plant and equipment.

ASSOCIATED ELECTRICAL INDUSTRIES Limited announce the following appointments. **Mr. W. Aspinall, M.Eng., J.P., A.M.I.E.E.,** has been appointed manager, general industry, North-Western Region. His office is at Quay Street, Manchester. **Mr. R. G. Riddle, B.Sc.(Eng.), A.M.I.E.E.,** has been appointed manager of the small industrial machines engineering department at the Birmingham Works of Associated Electrical Industries Motor and Control Gear Division. **Mr. R. G. Holland, A.M.I.E.E.,** has been appointed commercial manager of AEI Cable Division. In the Turbine Generator Division, Trafford Park, **Mr. F. R. Harris** has been appointed chief engineer, Large Steam Turbines, and **Mr. H. A. Kirby,** assistant chief engineer (Contracts), Large Steam Turbine Department. **Mr. C. F. Samuelson** becomes chief engineer, Geared Turbines (Gas and Steam) and **Mr. J. C. London,** chief engineer, Advance Turbine Development. In the General Engineering Department, **Mr. L. Abram** has been appointed chief engineer, **Mr. J. M. Brooks,** assistant chief engineer (Contracts), and **Mr. A. O. McEwan,** assistant chief engineer (Projects and Tenders). **Dr. J. H. Walker, M.I.E.E., A.M.I.Mech.E.,** has been appointed engineer-in-charge, A.C. Generators, Large Electrical Machine Engineering Department, Heavy Plant Division. **Mr. J. N. M. Legate, B.Sc., M.I.E.E** , has been appointed manager, Control Gear Engineering, AEI Motor and Control Gear Division, in Manchester, Rugby and Reading. He was previously manager of the division's Control Gear Engineering Department at Manchester. **Mr. W. H. Brodie, A.M.I.Mech.E., A.M.I.W.M.,** has been appointed assistant superintendent of transformer manufacturing at the Wythenshawe Works of Associated Electrical Industries (Manchester) Limited. **Mr. D. R. Fenwick, A.M.I.E.E.,** has been appointed chief engineer of the Instrument and Meter Department, Instrumentation Division. **Mr. John Churchill, B.Sc., A.Inst.P.,** who has been appointed chief engineer of AEI-Automation Limited, has been since 1960 chief engineer in the Process Control Department at Harlow of AEI's Instrumentation Division. **Mr. P. C. Spencer** has been appointed Rugby Publicity Office manager, to succeed **Mr. H. G. Harlow** who remains in an advisory capacity. Mr. Spencer's new duties are in addition to his present responsibility as Press Officer (Rugby).

Mr. Gordon Patterson, President of the Yale & Towne Manufacturing Company, New York, received the honorary degree of Doctor of Commercial Science at the 175th Anniversary Celebration Convocation of the University of Pittsburgh, Pennsylvania, U.S.A.

REDMAN TOOLS LIMITED of Worcester have appointed **Mr. V. W. Stokes** as sales manager in succession to **Mr. F. Archer** who has been appointed personal assistant to the managing directors. **Mr. F. C. Young** continues as director responsible for technical design.

POLLARD BALL & ROLLER BEARING Company Limited, the parent company, announce that **Mr. Walter C. Bass** has been appointed president and chief executive officer of R. & J. Dick Company, Inc. of Totowa, New Jersey, U.S.A. Mr. Bass was formerly president of American Pulley Company, Philadelphia, U.S.A. R. & J. Dick Company is a leading manufacturer of mechanical power transmission equipment with plants in the United States and Great Britain. The company became a subsidiary of Pollard in March, 1962.

JAMES BOOTH ALUMINIUM LIMITED announces that **Mr. Denis H. H. Clarke** has retired from the board of the company.

Mr. L. V. J. Hooper has retired his position as works director to Desoutter Brothers Limited. He will continue his service with the company as director of Research and Development. He is succeeded as works director by **Mr. E. A. Record.**

THE Eastern Region of British Railways announce the retirement of **Mr. E. H. Ker, M.B.E., A.M.I.M.E., M.I.Loco.E.,** locomotive engineer in the department of the Chief Mechanical & Electrical Engineer.

Mr. A. E. Bolton, A.M.I.Mech.E., has been appointed technical director of Aeroplane & Motor Aluminium Castings Limited, one of the Associated Engineering Limited, group of companies.

Mr. W. R. Slater, M.A.(Cantab.), A.M.I.C.E., A.M.I.Mech.E., formerly chief consulting production engineer of T.I. (Group Services) Limited, has been appointed production director to G.E.C. (Engineering) Limited. Mr. Slater succeeds **Mr. G. M. F. Donnelly** who has been appointed managing director of Witton-James Limited. Mr. Donnelly still retains his seat on the board of directors of G.E.C. (Engineering) Limited.

GEORGE ELLISON LIMITED announce the appointment of **Mr. P. C. Pritchard** as sales manager (United Kingdom).

Obituary

WE regret to announce the death of **Mr. Charles Alexander McLaren,** production director of Dewhurst & Partner Limited, Inverness Works, Hounslow.

Addresses

JOHN BULL RUBBER COMPANY LIMITED, Leicester, have established a plastics division providing a complete advisory, design and manufacturing service. Mr. A. E. Driver has been appointed sales engineer, plastics and polyurethane.

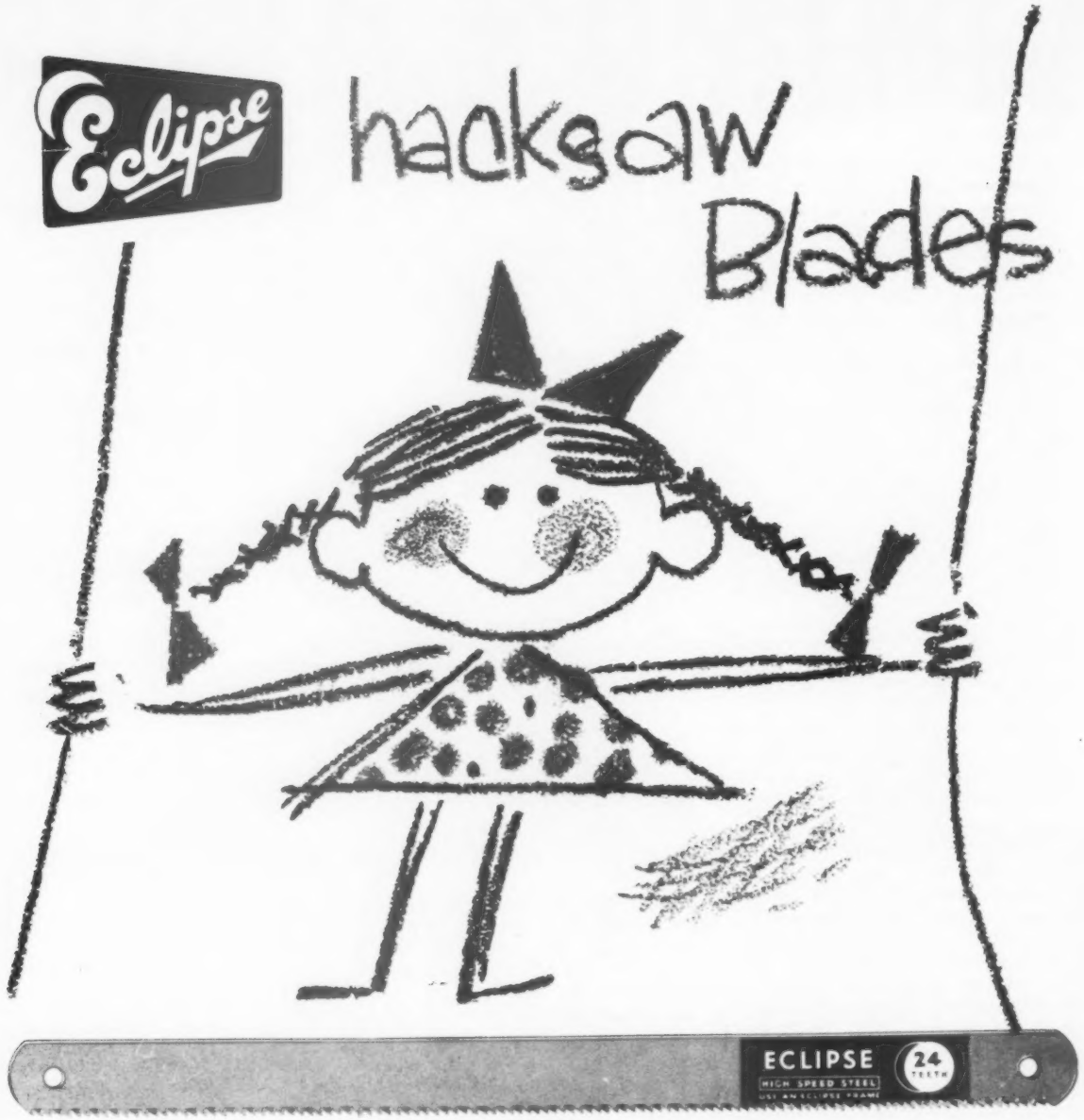
KINNIS & BROWN LIMITED, Aqua-Clear Water Treatment, 62, New Broad Street, London, EC2, have opened a branch office at 15 Allesley Old Road, Coventry, telephone: Coventry 75600, under the control of Mr. M. C. Ross, who is at present technical sales manager in the London area.

THE Leeds area office of Associated British Machine Tool Makers Limited have moved to Airedale House, Albion Street, Leeds, 1, (telephone, Leeds 23219).

A. C. COSSOR LIMITED, a member of the Raytheon Group of Companies, U.S.A., announce that the registered name of its subsidiary, Cossor Radar & Electronics Limited, has been changed to Cossor Electronics Limited.

ALPHA-MOLYKOTE CORPORATION, original developer of molybdenum disulphide solid lubricants for industry, has just started production in England. A new company under the title of Molykote Great Britain Limited, is now in operation at 21 Tidal Basin Road, Canning Town, London E16.

Eclipse hacksaw Blades



Daddy says they're Best

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

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Contracts and Work in Progress

DAVID BROWN INDUSTRIES LIMITED, Huddersfield.—Order from Babcock and Wilcox Limited for 32 large bevel helical gearboxes.

THE ENGLISH ELECTRIC COMPANY LIMITED. —Order worth over £100,000 for a self-contained diesel power station has been received from the Commission Federal de Electricidad of Mexico by the diesel engine division of English Electric. This order follows that for ten mobile generating stations ordered a year ago and now being delivered.

DAVIDSON & CO. LIMITED, Sirocco Works, Belfast.—Large ventilating plant contract for the Central Electricity Generating Board's Bankside power station, London, calling for 10 large axial-flow type Sirocco fans. Orders also for grit arresting equipment for boilers at the new Eggborough power station in Yorkshire.

WESTON WORKS (BIRMINGHAM) LIMITED, Greet, Birmingham 11.—Orders for four tipping gears and bodies worth a total of £1200 and for three new types of tipping gears and bodies placed at the Commercial Motor Show at Earl's Court.

THE BRITISH HOIST & CRANE COMPANY Limited, of Compton, Berkshire.—Order from War Office for twenty mobile cranes.

METALECTRIC FURNACES LIMITED, Smethwick.—Order to manufacture and erect at the new Tema Steelworks, near Accra, two 10 ton capacity direct arc melting furnaces, each rated at 4000 kVA.

DEWRANCE & CO. LIMITED.—Supply of boiler mountings and valves on four 500 MW La-Mont oil-fired boilers, for the new Fawley Power Station of the Central Electricity Generating Board.

WILLIAM BOBY & Co., Hertfordshire.—The Central Electricity Generating Board have awarded a contract worth more than £4000 for low pressure dosing and p.H. monitoring equipment at Bankside Power Station.

HUMPHREYS & GLASGOW LIMITED.—Contract worth nearly £3m for a complete gas separation unit to be built at Bratislava, placed by the Czechoslovak Government.

Contract for approximately £A1 million placed by Icianz Limited, Melbourne, for a urea plant to be established at Botany, New South Wales.

BTR INDUSTRIES LIMITED.—Two major contracts for rubber conveyor belting, valued together at more than £186,000, for installations in Italy and Poland.

WILLIAM BOBY & Co.—Order for two further de-aerators from The Power-Gas Corporation Limited.

BRISTOL SIDDELEY ENGINES LIMITED.—A third contract worth £1¼ million for the supply of four 17½ MW gas turbo-generators for Central Electricity Generating Board.

Business Developments

Company Acquisitions

GEORGE ANGUS & CO. LIMITED announce the formation of two new divisions, incorporating their associate companies, Fire Armour Limited and, in the home market, F. Reddaway & Co. Limited. The new divisions are Angus Fire Armour Division and Belting and Rubber Hose Division.

WOLF ELECTRIC TOOLS LIMITED, London W5, have acquired the business of their Dutch service agents "Arega" N.V. at The Hague, Holland.

ASSOCIATED ELECTRICAL INDUSTRIES Limited is to discontinue the manufacture of electric storage batteries, and the major assets of its Secondary Battery Department have been purchased by The Chloride Electrical Storage Company Limited.

Trading Agreements

FOLLOWING the plastics merger between Union Carbide Limited and Distillers Company Limited, Union Carbide announce that its organization will change only by transferring the polyethylene division to the new company, along with its holding in Bakelite Limited. Union Carbide Limited will continue to operate the remaining Alloys Division; Chemicals Division; and Kemet Division.

AGREEMENT has been reached between Stewarts and Lloyds Limited, the British steel and tube makers, and Taylor Forge & Pipe Works Inc., Chicago, Illinios, who manufacture flanges and pipe fittings to form jointly a new company to manufacture and sell welding fittings and flanges and associated piping components in the United Kingdom and world markets. The new company is Welding Fittings and Flanges Limited, and there will be a Canadian subsidiary, Welding Fittings and Flanges of Canada Limited.

ALFRED HERBERT LIMITED, Coventry, have signed an agreement with Wilhelm Fette, Germany, under which Alfred Herbert Limited manufacture in this country, under licence, several sizes of Fette self-opening thread-rolling heads, to be known as the Herbert/Fette Heads. An agreement also permits Alfred Herbert Limited to sell German made Fette thread-rolling products in this country.

A NEW subsidiary company of Baker Perkins Limited has been formed to operate the factories at Peterborough and Hebburn-on-Tyne, and will take over the name of Baker Perkins Limited. Baker Perkins as the holding company will in future be known as Baker Perkins Holdings Limited.

BTR INDUSTRIES LIMITED announces the integration of two of its subsidiary companies, Microcell Limited and Palmer Aero Products Limited, the resultant merger forming the Engineering Products Division of the Group. Microcell's Kingsway, London, offices will be vacated and the administration and design functions transferred to Camberley, Surrey.

Agents and Distributors

NUCKEY, SCOTT & CO. LIMITED, a member of the Tap & Die Corporation Group have appointed several new overseas agents.

MAIN distributors for Slydang, Limited, Hope Works, Sussex Road, Sheffield, manufacturers of adjustable steel shelving for the whole of Scotland are Sculthorps Limited, 105 Bath Street, Glasgow C2, and 91a George Street, Edinburgh 2. Main distributors for Northern Ireland are Joseph Blair Limited, 5 Church Lane, Belfast; and Geo. Tuckers & Co. Limited, Shoreham House, Shoreham Street, Sheffield, 1, have been appointed main distributors covering South Yorkshire, North Derbyshire, Lincolnshire and Nottinghamshire.

BWRA to Accept Foreign Members

MEMBERSHIP of the British Welding Research Association has now been opened to companies outside the United Kingdom, and applications have so far been submitted by organizations in Belgium, France, Switzerland, Sweden and the U.S.A. BWRA research work is well known internationally and tests developed by the laboratories are in use in many countries. The award to the Association of research contracts from the American National Aeronautics and Space Administration and from NATO were also noted recently.

New IWS Specialist Service

THE INDUSTRIAL WELFARE SOCIETY announces a new In-Company Supervisory Training Service for supervisors in industry, offices, hospitals and the retail trade. Further information is available from the Industrial Welfare Society, Robert Hyde House, 48 Bryanston Square, London W1.

Film News

Welding Copper and Its Alloys.—This new film is sponsored by the Copper Development Association. It shows a very wide range of processes, runs for 23 min. in 16 mm sound and colour. Copies are available on free loan upon application to the Copper Development Association at 55 South Audley Street, London W1.

£80,000 a Year Grant

THE DEPARTMENT OF SCIENTIFIC AND Industrial Research has offered the Civil Engineering Research Council a grant for an initial three-year period beginning January 1, 1963 subject to the Council's raising an annual income of not less than £40,000.

Throughout the world precision calls for Superfect* oil seals and hydraulic packings whatever the application or size required

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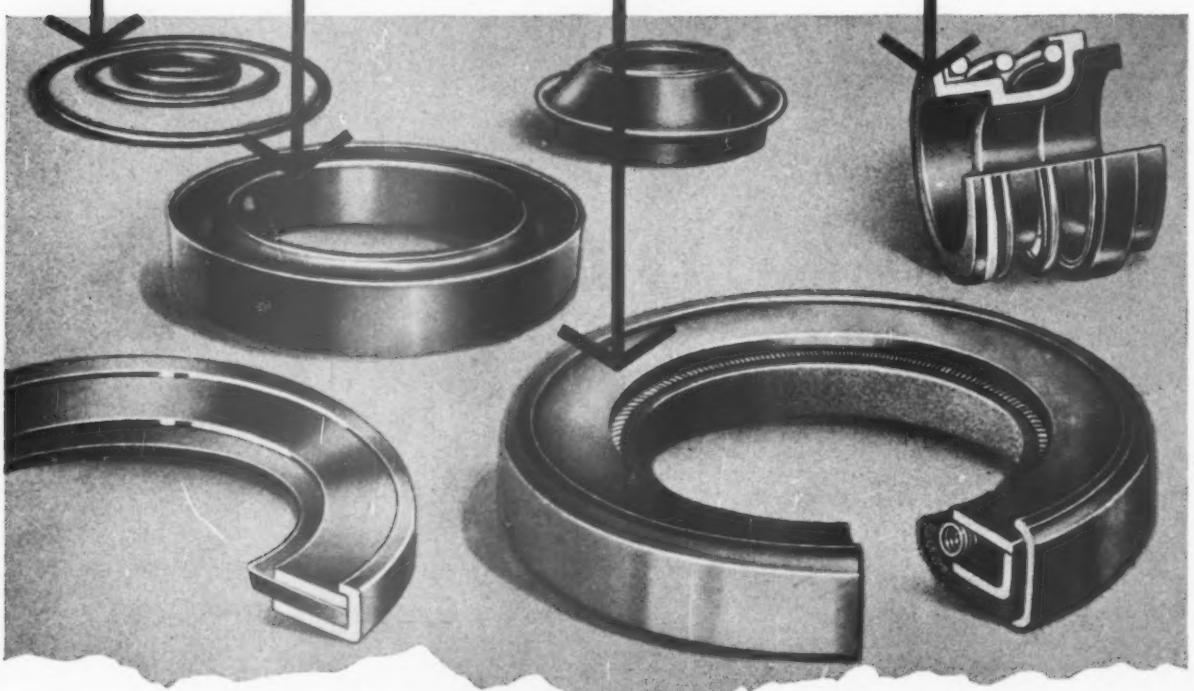
Designed primarily for rotary pumps, Romet Seals are in three types—diaphragm seal, single or double shaft seal, bellows seal.



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Floating Blankets

The technical findings of the National Engineering Laboratory on the Allpas floating blanket for open tanks are set out in a folder from Lacrinoid Products Limited, Gidea Park.

Conversion Tables

Two easy-to-read conversion tables—millimetres to inches and inches to decimals—printed on a 12 in. × 8 in. card are available free from Henry Rossell & Co. Limited, Effingham Road, Sheffield, 4, manufacturers of high speed steel drills and precision tools.

Malleable Castings

"Tensola" malleable pearlitic iron in grades I, II and III, and a new inert atmosphere electric tunnel type annealing furnace using a 45-hr cycle, are described in a brochure issued by Gloucester Foundry Limited, Gloucester.

Kendex Knee Tools

Knee tools primarily for use with Warner & Swasey 10° reversible cutter holders but also suitable for use in many other 10° holders as overhead tooling have been added to the Kendex range. Leaflets are available from Kennametal (Great Britain) Limited, Birmingham 4.

Tarex Automatic

The application of the Tarex hydro-copying automatics to small batch production is well explained in an illustrated brochure available free from Tarex (England) Limited, 22 Buckingham Gate, London SW1. The machine has a large number of independent tooling positions and operates by standard camming, no special cams being required.

Fly Ash for Grout

A brochure describing the use of fly ash in high and low pressure grouting has been issued by Stephenson Clarke (P.F. Ash Developments) Limited, 8 Gt. Tower Street, London EC3.

Pen Recorders

Two new recorders, fully transistorized and for using 6¾ in. wide chart, are described in a folder from Livingston Laboratories Limited, 31 Camden Road, London NW1.

Industrial Instruments

The following new publications are available from George Kent Limited, Luton: No. SS030, RA/C air and gas meter; No. 1011, Commander recorders, indicators etc., No. 2032, dissolved oxygen recorder; Mark 3 electronic measuring instruments; No. IN51, industrial electronic converters, No. IN52, converter controllers; No. IN53, Magnetic flow converters; No. IN54, general purpose electronic controllers; No. 2027, carbon content and liquid iron temperature recorder.

Sirocco Equipment

A new 20-page illustrated booklet has been produced by Davidson & Co. Limited, Belfast 5, describing their equipment for power stations and boiler plants.

Handling Equipment

A new illustrated leaflet from Taylor Stoker Company Limited, 189 Drummond Street, London NW1, gives particulars and dimensions of their Lo-Head electric overhead runway hoists. Two new leaflets deal similarly with the same maker's Lo-Effort heavy duty non-jamming valve for the control of bulk materials, and the Taylor Lo-head manual or power overhead travelling cranes.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Rotoplunge Pumps

Now available from Parkinson Cowan Measurement, 7-17 Fitzalan St., London SE11, is a new publication describing their Rotoplunge pumps Types 8G and 40G, the smallest types in the range, which is designed for use with liquids having some lubricating properties.

Concrete Vibrators

The latest catalogue of Flexmaster concrete vibrators (air and electric driven) includes two additional sizes, a 1 hp electric and a ¾ hp air driven set. The catalogue is obtainable from Gilman's Flexible Drives Limited, Warwick.

Products of United Steel

The United Steel Companies Limited, Sheffield, manufacture locomotives, watch springs, bridges, fine wire, heavy forgings, umbrella frames and steelworks plant. All these are listed alphabetically in the first part of a new book published by the company, the second part of which gives brief descriptions of the various branches and subsidiaries, together with details of the plant employed and the products and qualities made at each of them.

Powder Deposition

Dewrance Metals Division, Great Dover Street, London SE1, have issued a new edition of publication No. 671 describing the T.L.B. metal powder deposition torch. Powders now available meet the demand for a broad range of hardness values, from Rockwell C.15—C60. A tungsten carbide-containing powder gives hardness in excess of 950 dpn.

Cast Bronzes

A new brochure from Enfield Rolling Mills Limited, Enfield, lists sizes and properties of Encon continuously cast alloys in rods and tubes in a great variety of sections.

Fielding Presses

A new leaflet on Fielding presses has been published by Fielding and Platt Limited, Gloucester. The leaflet is printed in English, French and German.

Welding Sets

The new A-Range of air-cooled welding sets is described in Leaflet No. TL4 from Max Arc Limited, Walton-on-Thames.

Corrosion Prevention

The D.C.P. Basic System for rendering combustion gases non-corrosive is described in Brochure B37 from Dust Control Processes Limited, 5 Petty France, London SW1.

Heat Treatment

A folder issued by the West Midlands Gas Board sets out the advantages of using gas for heat treatment furnaces.

Precision Casting

BSH Castings Limited, Redditch, specialise in the manufacture of precision castings by the investment process. Two new folders describe the process and give particulars of tolerances, alloys, etc.

New Structural Steel

Appleby-Frodingham Steel Company, announce Hyplus, a new high yield stress weldable structural steel conforming to B.S.968: 1962. An eight-page leaflet giving chemical composition, mechanical properties and weldability of Hyplus, can be obtained on request to Appleby-Frodingham Steel Company, Scunthorpe, Lincs.

Vibrating Equipment

Two new publications, E120 and E121, describing the recently developed Sherwen Shearline series of vibrating equipment are now available from the Fraser & Chalmers Engineering Works of The General Electric Company Limited, Erith. The Shearline series embodies a novel system of rubber springing such that these high-capacity machines, while robust, are remarkably light in weight.

High Pressure Manometers

A leaflet from Bryans Aeroquipment Limited, Mitcham, describes two new high static pressure manometers, the Manoskop and the Magnetmanoskop.

Catalogues Received

Weather Clothing—SGB Building Equipment Division, Mitcham. RS/C Steam meter—George Kent Limited, Luton. Hot retort vacuum furnaces—Efco Furnaces Limited, Weybridge. Lorry mounted and crawler cranes—Arup & Arup Limited, 54 Uxbridge Road, Ealing. Positioner-Steuerungs-Systems (Deutsche)—EMI Electronics Limited,

Continued over.

Union Carbide SURVEY

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Over three times increased life for Austin Motor Company's milling cutters

Using standard sets of cutters milling oil grooves in main bearing caps made of special cast iron, The Austin Motor Company were obtaining a total of 650 sets of components per set of cutters. The objective of their Production Development Department was to improve the life of the milling cutters used in this operation.
The machines used were Austin indexing machines running at 100 rpm. Feed was 2" /min. (0.020" /rev.). The tools under test were S. & F.H.S.S. cutters with 24 alternate teeth.
Austin's P.D. Department decided to have six sets of milling cutters Flame Plated at the Union Carbide plant, at Warwick.

Production Performance Reported

As reported by the Austin Motor Company, the Table below shows that the average production of sets of components per set of cutters rose from 650 (standard cutters) to 2,827 (Flame Plated cutters):

SETS OF MILLING CUTTERS	NO. OF SETS OF COMPONENTS			
	INITIAL	AFTER REGRIND	TOTAL	% INCREASE
STANDARD SET	300	350	650	
FLAME PLATED:				
1ST SET	580	680	1260	94
2ND SET	850	2300	3150	385
3RD SET	1450	530	1980	205
4TH SET	2700	1330	4030	520
5TH SET	1375	1700	3075	373
6TH SET	1820	1650	3470	434
	AVERAGE INCREASE 335%			

(The variation in performance of the first Flame Plated set from the remainder was due to the development of the technique of plating and grinding for best results).

Wide Application

Other successful applications of Flame Plating are well established in powder metallurgy, pump manufacture and paper making. In the rubber, jute and asbestos industries, Flame Plated skiving knives have also shown outstanding increases in life.
On abrasive wear and frettage applications remarkable results have also been achieved. Flame Plated components like gauges, core rods, drills, taps, cutters and press tools of all kinds have their working life multiplied up to 50 times. Practically any surface can be Flame Plated—ceramics, plastics, light alloys and non-ferrous metals as well as steel.

The Process

Flame Plating is a unique process of applying an intensely hard skin of tungsten carbide to surfaces exposed to wear or abrasion. At the Union Carbide plant at Warwick, tungsten carbide powder is 'fired' by an oxyacetylene detonation in a 'gun' and projected onto the surface to be plated. However, the temperature of the workpiece never exceeds 200°C, and therefore no metallurgical disturbance takes place. It forms a wear resistant skin accurately controlled from .001 to .01 in. thick.
Union Carbide's qualified application engineers are available for an on-the-spot discussion of the possibilities of Flame Plating to relieve your wear problems. If Flame Plating will help your production methods, please write for further information, or ask for a Flame Plating engineer to call.

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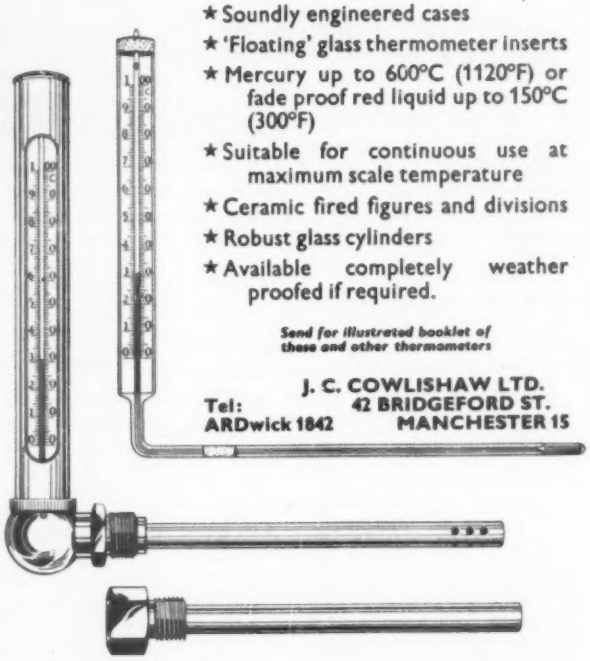

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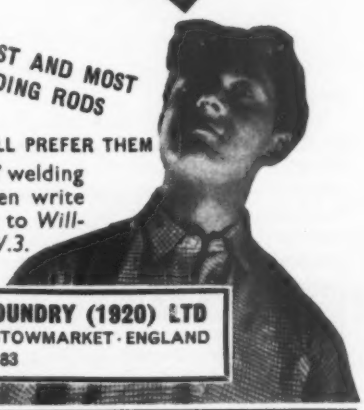

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TRADE LITERATURE—*Continued from previous page. Catalogues Received.*

Hayes. Ball bearing idler pulleys—Pollard Bearings Limited, Knottingley. Compressors and vacuum pumps—Tilghman's Limited, Altrincham. Precision balances—Baird & Tatlock (London) Limited, Chadwell Heath. Pushbutton switches—General Electric Company Limited, Birmingham. Flame- and weatherproof fluorescent light fittings—Victor Products Limited, Wallsend Automatic lathes—Tarex (England) Limited, 22 Buckingham Gate, SW1. Walking draglines—Ransomes & Rapier Limited, Ipswich. Flexible idler conveyor—Joy-Sullivan Limited, Greenock. Tungsten carbide burs—Gilman's Flexible Drives Limited, Warwick. Soffite tile flooring—Chipcrete Limited, 23 Willow Lane, Mitcham. Power and distribution transformers—The Transformer & Electrical Company Limited, Honeywood Road, Basildon. Pneumatic dust collection—Sturtevant Engineering Company Limited, Cannon Street, EC4. Tfe and fep sleeving and tubing—Polypenco Limited, Welwyn Garden City. Vernier callipers—James Chesterman & Co. Limited, Sheffield 11. Free machining aluminium alloy—Imperial Aluminium Company Limited, Box 216, Birmingham 6. Scientific Instruments—W. G. Pye & Co. Limited, Cambridge. Self-locking nuts and screws—Guest Keen & Nettlefolds Limited, Box 24, Birmingham 18. Radiant gas burners—G. & R. Gilbert Limited, Hackbridge, Wallington. Double-seal ball valves—Trowbridge, Pritchard & Co. Limited, Princes Buildings, Bath.

Longbenton (Northumberland). Godfrey and Syrett, Great Lime Road, West Moor, propose factory additions.

South Shields. C. W. Taylor and Sons. Plans are being prepared by R. T. James and Partners, Clavering Place, Newcastle-on-Tyne, for foundry additions at Templetown.

John Readhead and Sons, shipbuilders. Plans are being prepared by L. G. Mouchel and Partners, 24 Claremont Place, Newcastle-on-Tyne, for the erection of a fabrication shop.

Tynemouth. Cold Rolling Mills, North Shields. The contractors for additions are R. Jordan Limited, Back Queen Alexandra Road, Tynemouth.

Whitley Bay. Guy Temple Limited, builders and contractors, Hillheads Road, Whitley Bay, propose builder's yard, storage accommodation, joinery workshops, offices, and showrooms on the Foxhunters' Estate.

Accrington. James Broadley Limited, are to extend their works at Clayton-le-Moors.

Acton. Cerebos Limited, Victoria Road. Factory extensions.

Andover. Loco-motors Limited, Anton Mills, have applied for permission to build a new factory at South Street.

Ballymoney, Co. Antrim. M. C. B. Limited. A new factory is to be built by the Ministry of Commerce.

Biggleswade. Heald Machines, Kingsbury Road, Birmingham, are to erect a new factory at Dells Lane.

Blackburn. Daniel Thwaites & Co. Limited, Cleaver Street. Extensions are to be made to the brewery.

Bootle. English Electric Company Limited, Dinnings Bridge Road. Factory extensions.

Bournemouth. Meggitt Engineering Limited, 516 Wallisdown Road. Extensions are to be made to the factory.

Cheltenham. F. L. Douglas (Equipment) Limited. A new factory is to be built at Arle Village Road.

Chester. Hoover Limited, Western Avenue, Perivale, are to erect a new factory on the Sealand Trading Estate.

Crowdler Marr Limited, 22 Seller Street, Chester, are to erect a new factory on the Sealand Trading Estate.

Clifden, Co. Galway. Millars Connemara Tweeds Limited. New factory.

Coventry. Fred Lee & Co. Limited, are to build a new factory on Torrington Avenue industrial estate.

The Acme Salvage Metal Company Limited, Moat Street, are re-locating their works at Rowleys Green industrial estate.

Cowes (I.O.W.). Decca Radar Limited, Somerton, have received approval to extend their works.

Crayford. Canada Dry (London) Limited, Munster Road, London SW6. Approval has been received for the erection of a new factory at Thames Road.

New Factories

Croydon. C. Collins Limited, The Glass House, High Street. A new factory is to be built at Windmill Road.

P. Boyden & Co. Limited, Commerce Way. Factory is to be extended.

John Norman Limited, 97 St John's Hill, London SW11. A new factory is to be built at Gloucester Road.

Dagenham. Lakeside Ironworks Limited, Wantz Road. The architects for extensions to works are Anders & Dalton, 63 Cranbrook Road, Ilford.

Enfield. Thorn Electrical Industries Limited, Thorn House, Upper St. Martin's Lane, WC2, are to erect a new factory at Great Cambridge Road.

R. S. Lloyd Limited, Balham Road, London N9, are to erect a new factory at Duck Lees Lane.

Glasgow. Vilmay Limited. New factories are to be built at French Street and Reid Street.

Hastings. Elgin Metalcraft Limited, 16a Stamford Road, London N1. The architects for the new factory are Callow & Burstow, 59 London Road, St Leonards-on-Sea.

Atcost (Factories) Limited, High Street, Tunbridge Wells, are considering the erection of a new factory at Ponswood industrial estate.

Hendon. Desoutter Bros. Limited, The Hyde. The architects for extensions to the factory are Stanley Peach & Partners, 28 Eccleston Square, London SW1.

Leeds. Yorkshire Foundries Limited, are to extend their foundry in Albury Road.

A. & H. Upholstery Limited, Anchor Street. The works are to be reconstructed.

Tapp & Toothill Limited, Bramley Printing Works. Extensions are to be made to the works.

Leicester. Lathams (Leicester) Limited, are to erect a new workshop and showroom. The architects are Pick, Everard, Keay & Gimson, 6 Millstone Lane.

London. Practical Machines (A. T. Gadby) Limited, 46 Camberwell Green, London SE5, are to have a new factory erected.

Luton. Leagrave Press Limited, Mount Pleasant Road, are to extend their works.

Manchester. Weathergay Limited. Plans are being prepared for a new clothing factory at New Bridge Street.

Margate. T. & G. Tools Limited, Ramsgate Road, industrial estate. Works extensions.

Portsmouth. C. D. Jordan & Son, 1 St. John's Road; the Portsmouth Trading Company Limited, Vectis Way, Cosham; and the Reform Engineering Company Limited. New factories.

Redditch. Abel Morrall & Co. Limited. The factory at Edward Street is to be extended.

H. H. Barrett & Son, are to erect new workshops at Astwood Lane, Feckenham.

Swindon. Oppenheimer Casing Company (U.K.) Limited, Harrow Road, London W2. A new factory is to be built on the Greenfield Estate.

Treforest. Russell & Dorrell (Manufacturers) Limited, and Headings Limited, are to have new factories erected by the Industrial Estates' Management Corporation for Wales.

Uxbridge. Saxton & Co. (London) Limited, Eskale Road industrial estate. Extensions are to be made to the works.

Warrington. Metro-Cutanit Limited, Bellhouse Lane, Grappenhall, are to extend their works.

Watford. B. Walker & Sons Limited, Federal Way. Factory is to be extended.

West Bromwich. H. Geddes & Sons Limited, Neal Street. New factory.

Albion Spring Company Limited. Extensions are to be made to the works in Oldbury Road.

British Guide Rails Limited, Colls Lane, Hill Top, are to make extensions to their works.

Whitby. The Armour Chemicals Company, U.S.A., are to carry out a large potash extraction scheme.

Airdrie. Airdrie Electronics Limited (a Pye company) is to extend its factory space at Airdrie with B.O.T. support.

Bo'ness—West Lothians. Plastic Finishers Development Corporation has been formed to organize a series of small factories in the West Lothians area.

Glasgow. Voith Getriebe A.G. of Heidenheim, builders of hydraulic transmission gear and allied equipment, are joining in a new group which will operate the North British Locomotive Company Limited works at Queens Park, Glasgow.

Glenrothes. J. B. Butchart and Sons, Canal Street, Perth, wireworkers, are considering a new plant at Glenrothes Industrial Estate.

Grangemouth. The Town Council is to build six new small factories at a cost of approximately £20,000 for let to industrialists. The new units will be built at Bo'ness Road, Grangemough, the industrial development area of the town.

Leith. Scottish Agricultural Industries Limited are to erect a nitric acid manufacturing plant alongside their fertiliser factory at Leith Docks.

Loch Long. Jet Petroleum Limited have applied for planning permission for a deep water terminal and oil storage base at Portincaple on the eastern shore of Loch Long in Dumbartonshire.

CLASSIFIED ADVERTISEMENTS

Classified advertisements are inserted at the rate of 3/6 per line.

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Patents For Sale or License

THE Proprietors of Patent No. 818921 for Improvements in or relating to Liquid Fuel Supply Apparatus, desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Box No. PW49, 'MECHANICAL WORLD', 31 King St. West, Manchester 3.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling", offers same for licence or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

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THE proprietor of British Patent No. 817364, entitled "Improvements in rotary meters for liquids" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

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THE proprietor of British Patent No. 750963, entitled "Improvements in Gauging Apparatus for Use in Machining and Grinding Operations" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 753062, entitled "A method and apparatus for forming a true cylindrical surface on an elongated member, such as a crankshaft or a calender roll", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

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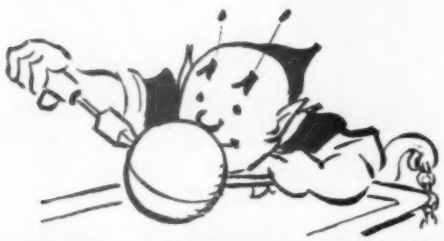

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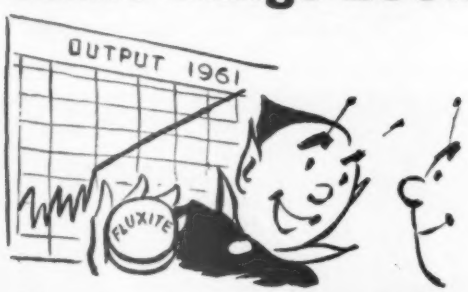

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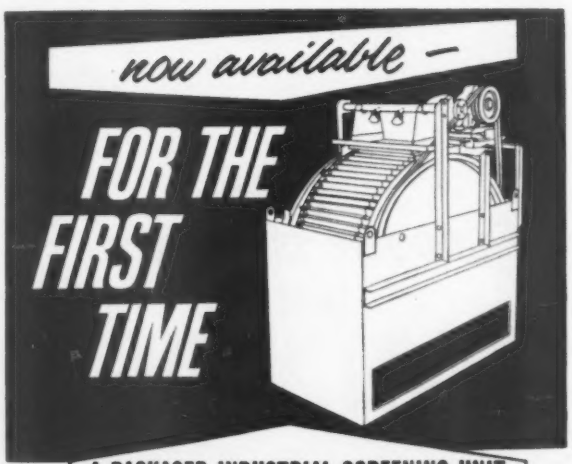

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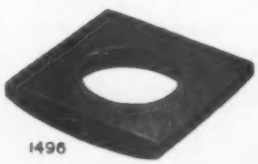

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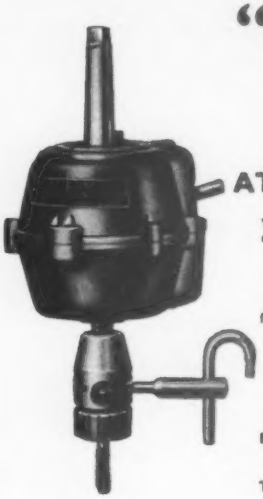

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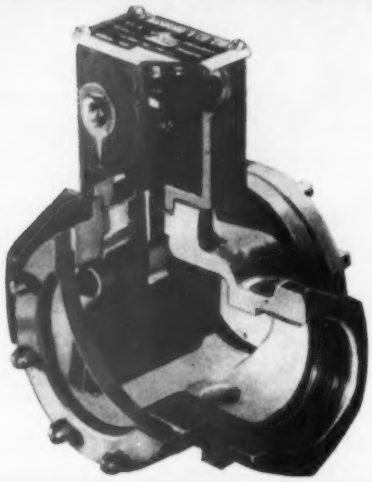

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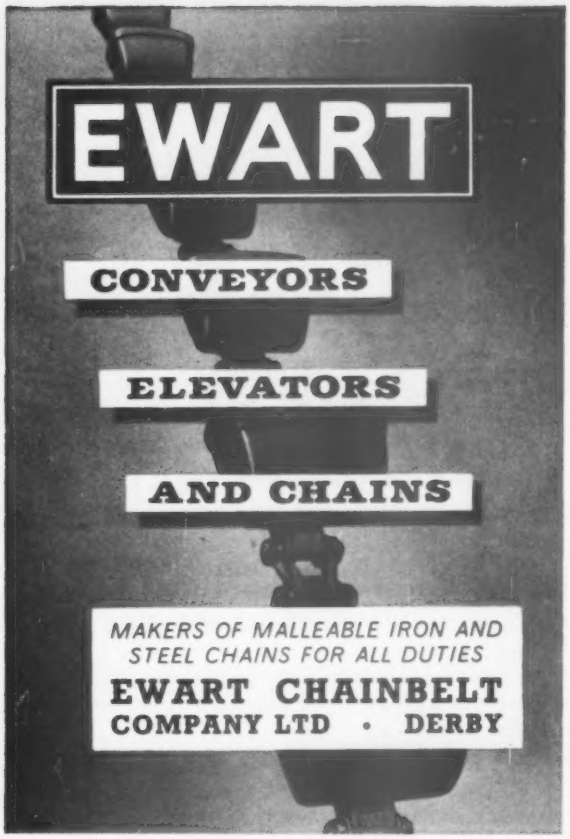

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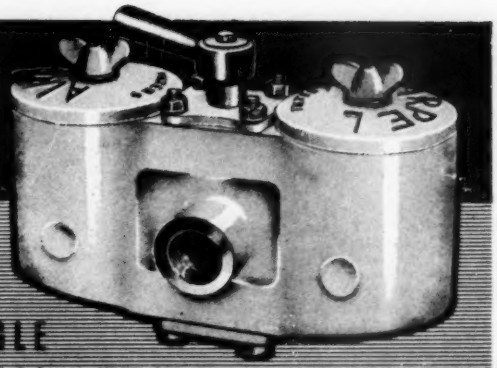

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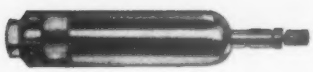

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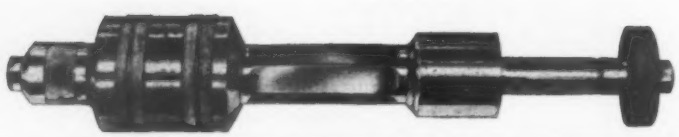

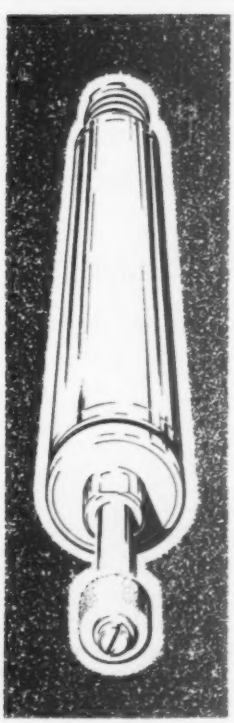

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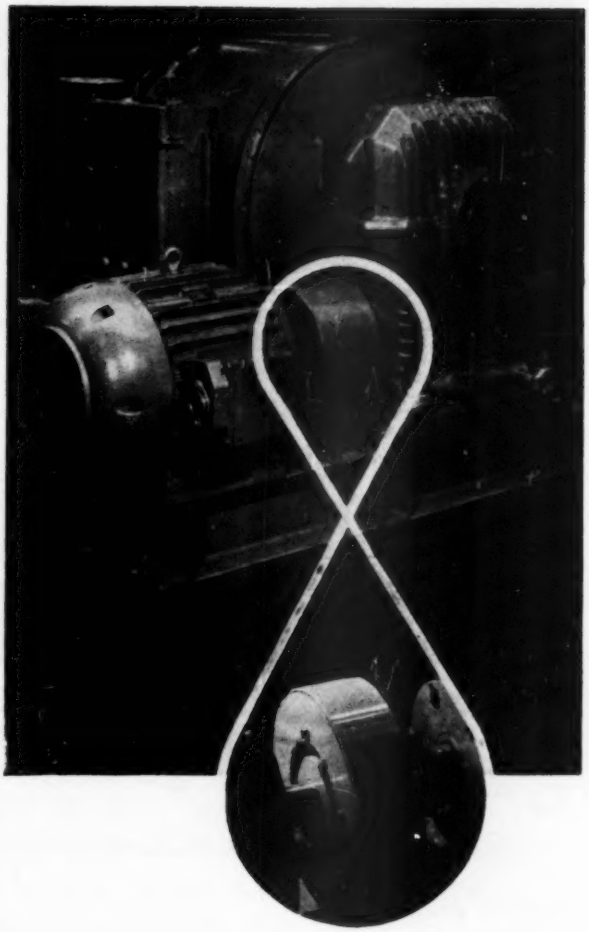

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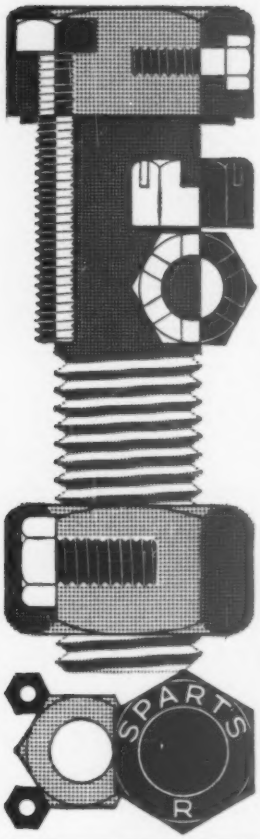

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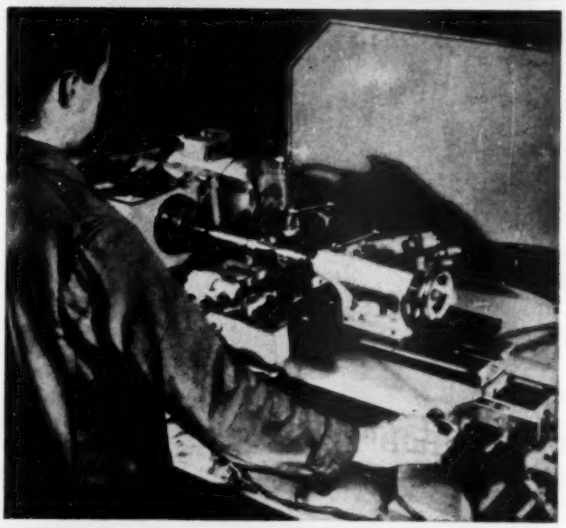

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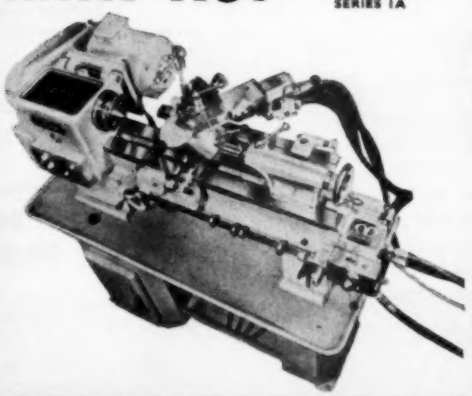

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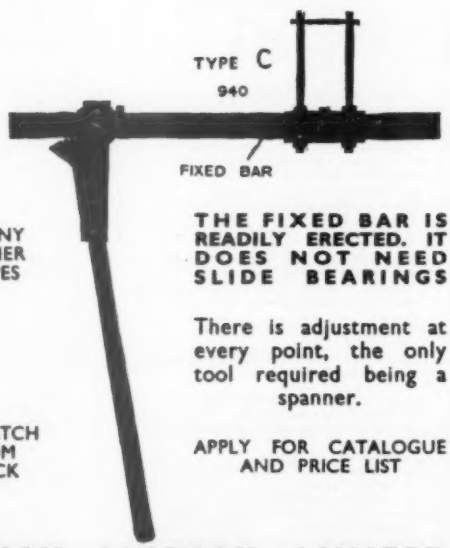

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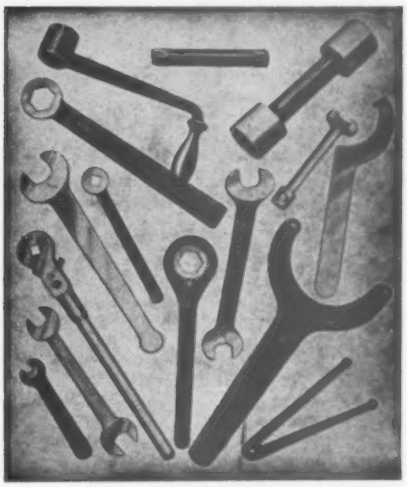

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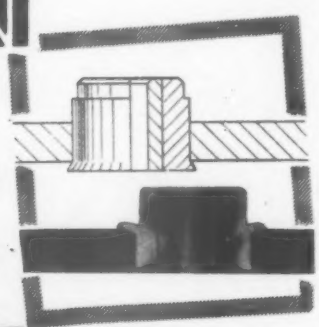

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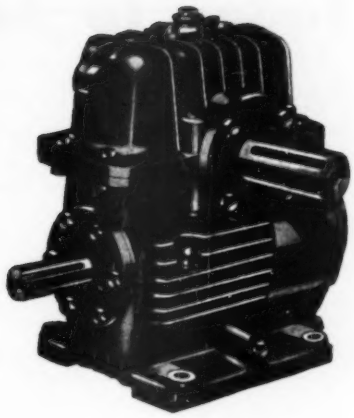

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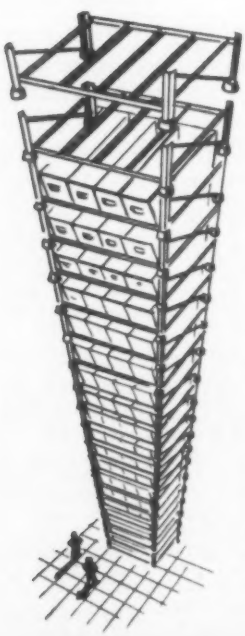

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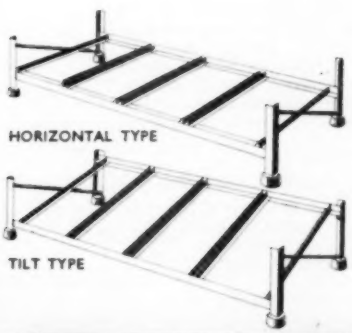

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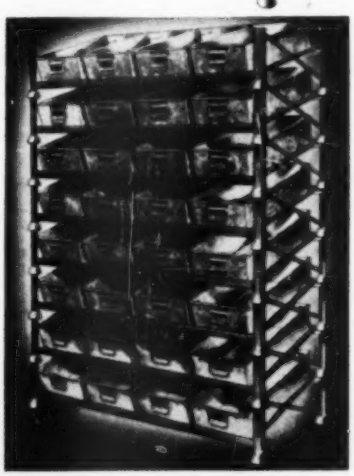

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